Contract Order No. 68-01-2851

March, 1976

METHODOLOGIES FOR THE ANALYSIS OF SECONDARY AIR QUALITY IMPACTS OF WASTEWATER TREATMENT PROJECTS LOCATED IN AIR QUALITY MAINTENANCE AREAS

Environmental Impact Office
Environmental Protection Agency
26 Federal Plaza
New York, New York 10007

B O O Z . A L L E N & H A M I L T O N Inc.
Management Consultants
4733 Bethesda Avenue
Bethesda, Maryland 20014
656-2200
Area Code 301

Contract Order No. 68-01-2851

March, 1976

METHODOLOGIES FOR THE ANALYSIS OF SECONDARY AIR QUALITY IMPACTS OF WASTEWATER TREATMENT PROJECTS LOCATED IN AIR QUALITY MAINTENANCE AREAS

Environmental Impact Office
Environmental Protection Agency
26 Federal Plaza
New York, New York 10007

B O O Z . A L L E N & H A M I L T O N Inc.
Management Consultants
4733 Bethesda Avenue
Bethesda, Maryland 20014
656-2200
Area Code 301

TABLE OF CONTENTS

L I S T O F F I G U R E S

LIST OF TABLES

I. INTRODUCTION

The Environmental Protection Agency has expressed concern that the Federal action of awarding sewage system construction grants, might contribute to community growth which in turn could adversely affect air quality in Air Quality Maintenance Areas (AQMA's). Thus in June of 1975, EPA solicited a study of the effect of AQMA requirements on the planning and design of sewage treatment projects. The study took place between June and December and included an assessment of the air quality implications of projects in the Town of Colonie, New York, and in Rockland County Sewer District No. 1.

The introduction to this report on that study is presented in the following sections:

- Background
- Objectives of the Study
- Applicable Air Quality Standards
- Characteristics on Air Quality Maintenance Areas
- Organization of the Report.

1. BACKGROUND

Application of various air pollution control measures has attained the national ambient air quality standards in most parts of the U.S. Application of more controls will result in the attainment of the standards in the remaining parts. However, continued urban growth in many metropolitan areas presents a potential for violation of these standards in the future. Such areas have been designated as Air Quality Maintenance areas (AQMA). In order to maintain the air quality in these areas below the national ambient air quality standards, careful planning of residential, commercial and industrial development is needed.

Another important consideration in planning for urban development is the provision of adequate wastewater collection and treatment facilities. The Federal Water Pollution Control Act Amendments of 1972 authorized the EPA to provide financial assistance to local municipalities and other responsible agencies to design and construct wastewater management systems within their jurisdictions. The wastewater projects are typically designed with a capacity to serve a 20- to 50-year projected population (20 years for wastewater treatment units and 50 years for interception). Construction of such projects in an AQMA may contribute to urban growth which may have adverse air quality impacts. EPA does not wish to fund water pollution control projects which may at a later date, contribute to violations of ambient air quality standards.

2. OBJECTIVES OF THE STUDY

The sizing of wastewater collection and treatment facilities is based upon growth projections for an area. If these growth projections would result in the future violation of ambient air quality standards, it is EPA's desire to limit Federal funding of such facilities to a capacity consistent with these standards. The intent of this report is to provide a procedure for applicants to assess the air quality implications of proposed wastewater collection and treatment facilities, and a procedure for EPA to assure that all grant applicants give due consideration to air quality impacts in project planning.

The specific task set forth in the work statement included the following:

- EPA methodology. Develop a methodology which EPA can use to assure that all sewage treatment plant applicants give due consideration to air quality impacts in project planning.

- Applicant procedures for air quality assessment. Propose methodologies for use by wastewater project grant applicants to assess the impact of their plans on ambient air quality, and including the following specifics:

    - Determine whether the design population might result in standards violations for each pollutant for which the areas have been designated AQMA's

    - Recommend possible mitigative measures, where standards violations are indicated likely

    - Provide for consideration of cumulative effects of several sewage treatment projects on the same AQMA

- Project evaluation. Evaluate and make recommendations for two test projects in the Town of Colonie and Rockland County.

3. APPLICABLE AIR QUALITY STANDARDS

National ambient air quality standards have been established for both total pollutant concentration and for incremental changes in pollutant concentration. These standards are summarized below. In addition, the states are permitted to establish more stringent standards which must also be considered in assessing the impact of a Federal action. Such standards for the states in EPA Region II are included in Appendix D.

(1) National Ambient Air Quality Standards (NAAQS)

The NAAQS have been established for six air pollutants: sulfur dioxide (SO_2), total suspended particulate (TSP), nitrogen dioxide (NO_2), carbon monoxide (CO), hydrocarbons (HC), and photochemical oxidants (O_x). Although a separate standards for hydrocarbons is given, attainment of the oxidant standard is considered to assure the attainment of the hydrocarbons standard. The NAAQS consist of primary and secondary standards. The primary standards are designed to protect the human wealth whereas the secondary standards are intended to protect the public welfare (property damage, aesthetics, etc.). The NAAQS are given in Table I-1.

(2) Incremental Ambient Air Quality Standards (Deterioration Criteria)

These criteria are designed to prevent significant degradation of air quality in areas having air

Table I-1
National Ambient Air Quality Standards

Pollutant	Primary Standards	Secondary Standards
Sulfur Dioxide	80 ugm/m^3 (aam) 0.03 ppm	1300 ugm/m^3 0.50 ppm (3 hr.)[1]
	365 ugm/m^3 0.14 ppm (24 hr.)[1]	
Total Suspended Particulate	75 ugm/m^3 (agm)	60 ugm/m^3 (agm)
	260 ugm/m^3 (24 hr.)[1]	150 ugm/m^3 (24 hr.)[1]
Carbon Monoxide	10 mgm/m^3 (8 hr.)[1] 9 ppm	10 mgm/m^3 (8 hr.)[1] 9 ppm
	40 mgm/m^3 (1 hr.)[1] 35 ppm	40 mgm/m^3 (1 hr.)[1] 35 ppm
Photochemical Oxidants	160 ugm/m^3 (1 hr.)[1] 0.08 ppm	160 ugm/m^3 (1 hr.)[1] 0.08 ppm
Non-methane Hydrocarbons	160 ugm/m^3 [1,2] 0.24 ppm	160 ugm/m^3 (3 hr.)[1,2] 0.24 ppm
Nitrogen Dioxide	100 ugm/m^3 (aam) 0.05 ppm	100 ugm/m^3 (aam) 0.05 ppm

1 — not to exceed more than once a year
2 — 6 a.m. to 9 a.m.
aam = annual arithmetic mean
agm = annual geometric mean
ugm = microgram
mm = milligram
ppm = parts per million
m^3 = cubic meter

quality better than national standards. These criteria are established only for sulfur dioxide and total suspended particulates. While the NAAQS apply to net pollutant concentration, the significant deterioration criteria apply only to incremental concentration. There are three different sets of criteria applicable to three different classes of areas in the country:

- Class I represents those areas in which any commercial and industrial development may result in significant degradation of existing air quality

- Class II represents those areas in which development associated with normal growth rate may be tolerated

- Class III represents those areas in which degradation of air quality up to national standards may not be significant.

The allowable incremental concentrations for Classes I and II are shown in Table I-2. For Class III, the ambient air quality may degrade up to the NAAQS.

Currently, all areas in the nation are designated as Class II. However, the states have the option to reclassify any part of the state after conducting a public hearing for each reclassification action.

Table I-2
Significant Deterioration Criteria

Pollutant	Allowable Increments	
	Class I ug/m^3	Class II ug/m^3
<u>Particulate matter</u>		
Annual geometric mean	5	10
24-hour maximum	10	30
<u>Sulfur dioxide</u>		
Annual arithmetic mean	2	15
24-hour maximum	5	100
3-hour maximum	25	700

For Class III, the above concentrations could increase until the air quality degrades up to the national ambient standards.

If comparison of expected pollutant concentration with air quality standards shows potential for violation of the standards, the next step in the analysis as indicated in the decision flow diagram should be taken. When no violation is indicated, the project should be approved from air quality perspective.

4. CHARACTERISTICS OF AIR QUALITY MAINTENANCE AREAS

The Air Quality Maintenance Areas represent those areas which, because of existing air quality and projected growth rate, may have the potential for exceeding any National Ambient Air Quality Standards during the ten-year period between 1975 and 1985. AQMA's are designated by the states and may be structured in accordance with one or more of the following groupings:

- Standard Metropolitan Statistical Areas (SMSA)
- Air Quality Control Regions (AQCR) (designated originally by the Department of Health, Education and Welfare as regions having common air pollution problems)
- Urbanized areas
- Counties
- Groupings of: cities, townships, and boroughs
- Planning regions used for land use, transportation, or other planning
- Sub-state planning districts.

The AQMA designation is pollutant specific. An area may be an AQMA for one or more of the following pollutants for which national ambient air quality standards exist:

- Particulate matter
- Sulfur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Carbon monoxide (CO)
- Photochemical oxidants (O_x).

However, regardless of the pollutants designated for a given AQMA, the AQMA has a single boundary.

EPA currently is requiring that each state prepare an AQMA plan, as a part of the state implementation plan, consisting of modified or additional regulations necessary to ensure future maintenance of ambient air quality standards. When such plans are completed, they will serve as the basis for the establishment of design populations and will provide for land use controls required to maintain air quality. Thus, they will likely preclude the necessity for most of the air quality analyses described in this report.

5. ORGANIZATION OF THE REPORT

The remainder of the report is presented in four chapters and appendices as described below:

- II. Overview of the Air Quality Impact Analysis Requirements

  Describes the basic procedural steps proposed for an applicant to assess air quality impacts.

- III. <u>Alternative Air Quality Analysis Methods</u>

  Summarizes available methods for air quality analysis, references EPA and other reports on each method, and presents the advantages and disadvantages of each.

- IV. <u>Proposed Methodology to Screen Wastewater Projects for Adverse Secondary Air Quality Impacts</u>

  Describes in detail the proposed air quality analysis procedure for screening sewage sys-construction grant applications for potential violations of ambient air quality standards.

- V. <u>Study of Two Test Projects</u>

  Presents results of application of the proposed methodology to two test projects in EPA Region II.

- Appendices

  - A. Overview of Possible Air Pollution Mitigating Measures

  - B. Discussion of Methods to Estimate Vehicle Miles Traveled (VMT).

  - C. Application of the Proposed Methodology to Estimating the VMT in Rockland County Sewer District Number 1.

- D. State Air Quality Standards in EPA Region II.

- E. Input Requirements of the Modified Rollforward Model for CO

II. OVERVIEW OF THE AIR QUALITY IMPACT ANALYSIS PROCEDURE

This chapter describes the steps proposed to be followed by a sewage project grant applicant in assessing the air quality impacts of his project. It is presented in the following parts:

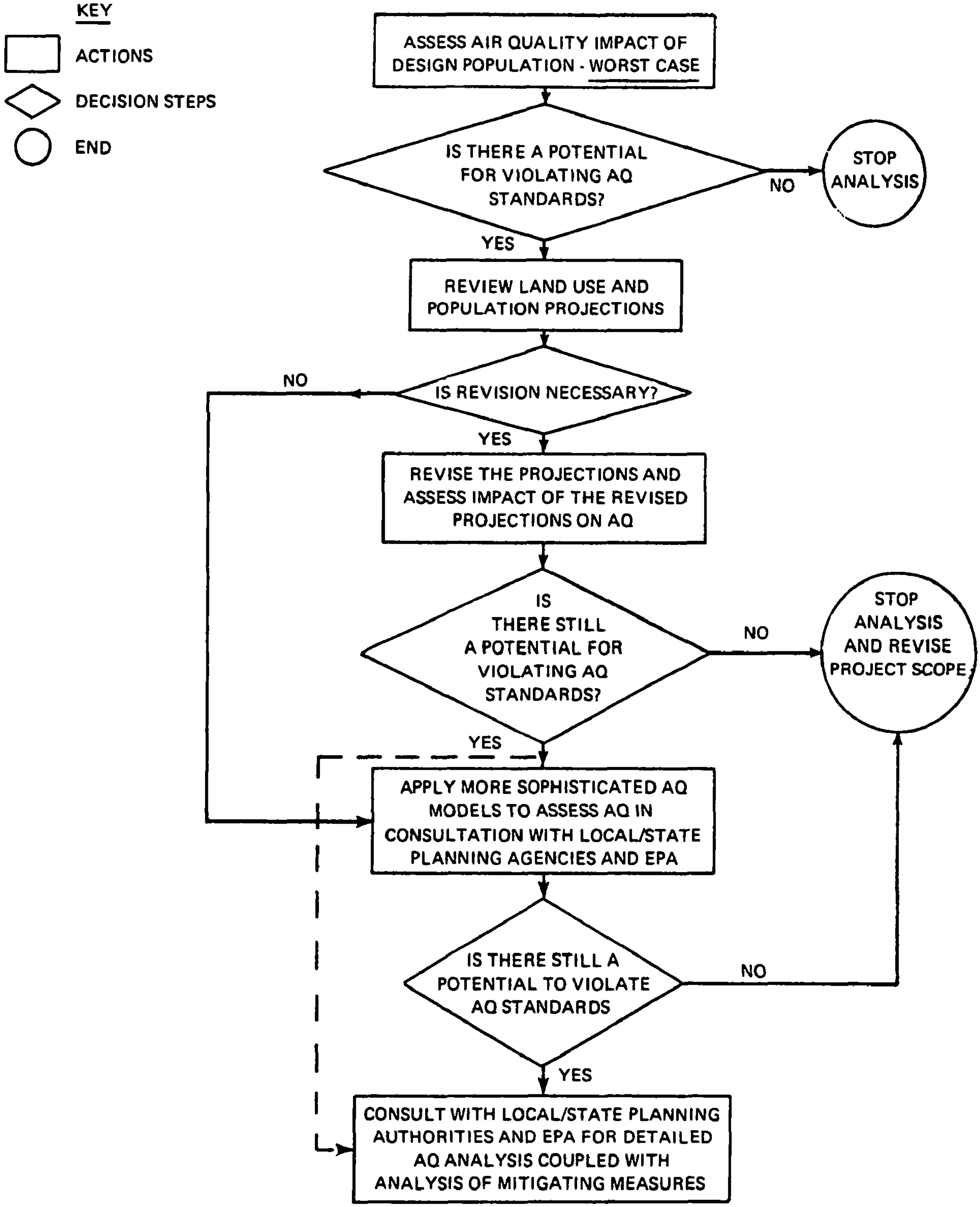
- The Decision Process
- Considerations in Land Use and Population Projections.

1. THE DECISION PROCESS

A procedure is proposed for use by sewage project grant applicants to screen their projects for possible air quality impacts. This procedure is depicted in Figure II-1 and is characterized by the following four sequential steps, with each additional step required only if air quality problems are still indicated:

- A simple and conservative method is proposed to assess air quality and screen projects
- A review of land use and population projections is proposed, since recent growth projections frequently do not fully recognize declining population growth rates.

FIGURE I-1
Decision Flow Diagram



- More sophisticated air quality assessment procedures are suggested, to be applied in consultation with local/state environmental staffs.

- Consultation with local/state planning officials is suggested to consider mitigative measures for air quality, which will generally be outside the scope of the applicant.

Considerations in reviewing population and land use projections are discussed in the following section.

2. CONSIDERATIONS IN LAND USE AND POPULATION PROJECTIONS

If the worst case analysis based on design population indicates a potential for violation of ambient air quality standards, the design population projections should be carefully reviewed. As mentioned above, recent population projections do not frequently recognize declining growth rates. Reevaluation of a population estimate that underlies a wastewater system design will be required in the following cases:

- Changes in population subsequent to the date of the estimate indicate a high probability that the estimate is overstated

- The estimate is based on an extrapolation of the trend for a small area

- The estimate is based on an extrapolation of a trend for a larger area (SMSA or state) but for too short a time period or for a nonrepresentative time period.

- The share of a larger area's projected development assigned to the service area of the proposed system has <u>not</u> considered:

  - The amount of land available for development or redevelopment within the service area of the proposed facility

  - Transportation access and travel times to work centers

  - Attractiveness of the area with respect to recreational facilities and other community services.

Population projections meeting these criteria will be revised accordingly, so that valid projections are available for the subsequent analysis.

III. ALTERNATIVE AIR QUALITY ANALYSIS METHODS

Depending upon the availability of data and analytical resources, there are different ways to determine air pollutant emissions in an urban area, and relate them to the ambient air quality. This chapter discusses the various factors affecting air quality and presents a general approach to air quality analysis. Alternative methods available for obtaining emissions data are discussed, together with alternative atmospheric simulation models available for translating emissions into air quality. The organization of the chapter is as follows:

- Factors Affecting Ambient Air Quality
- General Approach to Air Quality Analysis
- Alternative Methods for Preparing Wastewater Service Area Emission Inventory
- Alternative Atmospheric Simulation Models.

1. FACTORS AFFECTING AMBIENT AIR QUALITY

Ambient air quality is generally measured at ground level, where people and property are most often exposed to the air pollutants. The ground level concentration of air pollutants at a typical urban monitoring site depends upon many factors including:

- Rate of pollutant emission in the area
- Geographic distribution of the emission sources
- Source operating conditions including
    - Elevation of emission source
    - Temperature and velocity at which the pollutants are emitted
- Meteorological conditions including
    - Wind direction and speed
    - Atmospheric stability
- Topography
- Pollutant decay and the rate of reaction of an air pollutant with other air pollutants and atmospheric substances.

Each of these factors is discussed below.

(1) Emission Rates

If all the other factors are held constant, the contribution from an air pollutant emission source to the ambient pollutant concentration at a downwind receptor point is directly proportional to the rate at which it is discharged into the atmosphere. However, the total ambient concentration at the receptor point is generally made up of contributions from a large number of emission sources and the natural background levels. Since the other factors, especially the geographic distribution of the emission sources, usually do not remain constant, the ambient concentration at an urban receptor point does not vary in direct proportion to the overall emission rate.

(2) Geographic Distribution

The ambient concentration of an air pollutant varies with distance from the source because of mixing and dilution with the air. In addition, changes in wind direction alter the path of the pollutant. Thus the pollutant concentration at a receptor (monitoring site) is greatly influenced by the relative location of the emission sources.

(3) Source Operating Conditions

Most air pollutants are formed as products of combustion and are typically emitted through a stack or an exhaust vent. The exhaust gases are generally warmer and hence lighter than the surrounding air. Because of their initial momentum and buoyancy, these gases tend to rise through the air until an equilibrium with the surrounding air is reached. Their ultimate rise depends on the physical stack height and diameter, exhaust temperature and velocity and local meteorological conditions. The ground level concentration of the pollutants is inversely proportional to the total rise of the pollutants in the atmosphere.

(4) Meteorological Conditions

Speed and direction of wind and atmospheric stability play an important role in dispersing the air pollutants. Higher wind speeds generally tend to rapidly disperse the pollutants and reduce their concentration. Similarly, changing wind direction distributes the pollutants around the emission source. Greater atmospheric stability tends to reduce the plume rise with resulting higher ground level concentrations. However, the actual pollutant concentration depends upon the combination of all meteorological conditions.

(5) Topography

Local topography influences the air flow patterns in the region, which in turn affect the pollutant dispersion. The air flow in a valley, for example, is quite different than that over relatively flat, unobstructed terrain. Because of the flow restrictions, the pollutant concentrations in a valley may be significantly higher than those in an area with flat terrain. Differences in elevations between emission sources and receptor sites may also affect the ground level pollutant.

(6) Pollutant Decay and Reactions

Some of the air pollutants remove themselves from the atmosphere by settling down or they react with other substances in the atmosphere to form new substances.

The particulates, for example, coagulate to form larger and heavier particles which eventually settle down. However, at the same time, pollutants such as SO_2, react with atmospheric substances to form other sulfur compounds, some of which remain suspended in the atmosphere as particulates.

Similarly, the photochemical oxidants are formed in the amosphere as products of chemical reactions involving the nitrogen oxides, reactive hydrocarbons, and sunlight.

The mechanisms of pollutant decay and the chemical reactions mentioned above are not yet fully understood.

2. GENERAL APPROACH TO AIR QUALITY ANALYSIS

The principal objective of an ambient air quality impact analysis of wastewater projects is to predict expected air pollutant concentrations in the study area as a result of changes in the urban environment. Such concentrations can then be compared with the applicable air quality standards.

The process of relating changes in the urban environment to ambient air quality involves several steps:

- Identify and quantify existing air pollutant emission activities in the study area

- Determine emission factors for converting the emission activities into emissions

- Determine existing emissions

- Obtain existing air quality and meteorological data and estimate background concentration

- Relate existing emissions to existing ambient air quality by using atmospheric simulation models

- Determine growth factors for the emission activities during the desired time period

- Determine the future emission factors for the desired year

- Project emissions to the desired year

- Project ambient air quality to the desired year.

The existing emissions and air quality data are required when using certain air quality models such as the proportional rollforward model. This information is also useful for calibrating other air quality models. The individual steps in the above process are discussed in detail in Chapter IV. The next two sections in this chapter discuss the alternative methods for preparing an emissions inventory and alternative atmospheric simulation models for analyzing the air quality.

3. ALTERNATIVE METHODS FOR PREPARING WASTEWATER SERVICE AREA EMISSION INVENTORY

There are two approaches to preparing an emission inventory for a wastewater project service area.

- Estimate countywide emissions and allocate them to the service area
- Directly estimate the service area emissions

The first method is recommended when local data are not readily available. It requires less effort than the second method, but the second method is more accurate. These methods are discussed below.

(1) Determining Wastewater Service Area Emissions from Countywide Emissions

This method consists of the following steps:

- Estimate existing countywide emissions
- Allocate county emissions to the wastewater service area
- Project future service area emissions.

The first step relies on available county emissions data. Most states have developed estimates of countywide emissions for 1975 as part of their State Implementation Plans. The countywide emissions inventory is also maintained in the National Emission Data Systems

(NEDS) operated by the U.S. EPA. The states are required to update the NEDS inventory every six months. The NEDS data are published annually. However, latest data are available on request through the EPA regional office. If countywide data are not available, the alternative methods discussed in the next section should be used.

The county emissions can be allocated to the wastewater service area by using different allocation parameters. For example, emissions from countywide residential fuel combustion may be allocated to the wastewater service area using the ratio of the service area population to the county population. Volume 13, of the EPA guidelines mentioned above presents several methods for allocating county emissions to subcounty areas.(1) These methods are discussed in Chapter IV.

Once the existing emissions for the service area are estimated, future emissions can be projected using projection methods described in Chapter IV.

(2) DIRECTLY ESTIMATING SERVICE AREA EMISSIONS

This method relies on local emissions data obtained primarily through interviews with state and local planning agencies and operators of major emissions sources in the service area. The EPA has published guidelines for estimating existing as well as future emissions for a county or smaller area.(2) The procedures given in these guidelines can be applied to estimating emissions in the wastewater service areas.

As an aid in determining the effects of future land use patterns on the service area's emissions, emission factors based on different types of land use may be developed as shown in Table III-1. The emission factors shown in Table III-1 are highly specific to the particular study area. An attempt was made by Argonne National Laboratory to develop generalized land use emission factors, but the results were inconclusive.[3] Thus, it would be necessary to develop separate land use emission factors for each service area, which may be impractical for this analysis.

4. ALTERNATIVE ATMOSPHERIC SIMULATION MODELS

Atmospheric simulation models are designed to predict ambient pollutant concentration by using the emissions data. A number of different atmospheric simulation models have been developed because:

- The six criteria pollutants exhibit different source-receptor relationships, requiring different analytical treatment.

- The ambient standards are specified in terms of pollutant concentration averaged over different time periods, which also require different analytical treatment.

- The atmospheric processes affecting the ambient concentrations are complex in nature and, therefore, cannot be uniquely simulated.

Table III-1

An Example of Developing Emission Factors Based on Land Use

Land Use Category	Pollutant Emissions (lb/year/acre)				
	TSP	SO_2	CO	HC	NO_x
Residential					
10 Dwelling units/acre	25	1	35	12	7
20 Dwelling units/acre	180	120	4	54	85
30 Dwelling units/acre	180	120	4	54	85
50 Dwelling units/acre	250	160	5	75	120
80 Dwelling units/acre	200	140	4	63	100
Commercial & Industrial					
Commercial	60	45	1	12	95
Manufacturing - Light	1100	1100	10	140	850
Manufacturing - Heavy	5400	5400	60	900	5400
Research	2	15	1	5	35
Distribution	60	45	1	12	95
Special Use	60	45	1	12	95
Airport*	100	1000	3000	350	100
Transport Center	180	130	2	36	300
Cultural Center	45	35	1	9	70
Open Space	0	0	0	0	0
Other**					
		Emission Factors			
Highway (lb/10^6 VMT)	700	400	11000	1000	1500
Parking lots (lb/10^3 hrs idling)	4	4	12	3	1

* Assumes 400,000 flights/year from Teterboro Airport, and 700 acre area.

** Activities are not specified on basis of omissions/ unit area.

Source: The Hackensack Meadowlands Air Pollution Study Summary Report, Environmental Research and Technology, October 1973.

- Detailed emissions data are not always available, and different assumptions must therefore be made.

Commonly used atmospheric simulation models applicable to specific pollutants and averaging times are shown in Table III-2. Other models, such as the Sampled Chronological Input Model and the SAI Photochemical Model are still being tested and are not available for general use. These models are discussed below.

(1) Simple Rollforward Model[4]

The simple rollforward model is based on an expression relating pollutant concentrations (X) to pollutant emission rates (Q) and a background concentration (b):

$$X = kQ + b. \qquad \text{(Eq. III-1)}$$

The rollforward model assumes that the dispersion parameter k does not vary with time or with the source-receptor relationship, and that changes in emission rates are uniform across the area. Thus the relationship of emissions (Q_{future}) and air quality in a future year (X_{future}) to the emissions (Q_{base}) and air quality (X_{base}) in a base year can be expressed by the following proportionality:

$$\frac{X_{future}-b}{X_{base}-b} = \frac{Q_{future}}{Q_{base}} \qquad \text{(Eq. III-2)}$$

Table III-2

Commonly Used Air Quality Models*
Applicable to Specific Pollutants and Averaging Times

SO_2 and TSP Annual Average	SO_2 and TSP 24-Hour Average	SO_2 and TSP 3-Hour Average
AQDM, CDM, FAQM Hanna-Gifford Miller-Holzworth Rollfoward	Hanna-Gifford*** with point source model AQDM,** CDM,** FAQM** Rollforward	Hanna-Gifford*** with point source model AQDM,** CDM,** FAQM** Miller-Holzworth*** Rollforward

CO 1- & 8-Hour Average	O_X 1-Hour Average	NO_2 Annual Average
APRAC-1A*** Hanna-Gifford*** with HIWAY Modified Rollforward	Appendix J	Rollforward

Source: Based on reference 4.

---

* Listed in descending order of level of detail and applicability.

** Statistical conversion of averaging times required.

*** Repetitious application of model to each hour under consideration is required for averaging times longer than 1-hour.

The basic assumption in the model is that a given percent reduction or increase in pollutant emissions will result in a similar reduction or increase in pollutant concentrations. It is simply a tool for scaling concentrations up or down to reflect similar changes in the gross emission rates.

The rollforward model is applicable to most pollutants and averaging times as shown in Table III-2. Input to the rollforward model requires total area-wide emissions for the base year and for 1985 or other years of interest. A pollutant concentration representative of air quality for the area and the averaging time of interest is also necessary. It should be noted that since there is no allowance for specifying the dispersion parameter k or other meteorological parameters, this model cannot be used to estimate concentrations at sites where representative air quality data do not exist.

The rollforward model is applicable anywhere for which there are basic data on area-wide emissions and representative air quality for a particular base year. The simple rollforward model can be applied with hand calculations and is widely used.

The rollforward model in general is valid for the simplified case of only one type of source uniformly distributed across an area affecting a receptor. Accuracy is lost as the variability of source types and emission rates increase and the impact of atmospheric processes on pollutant concentration increase. Thus, due to the importance of point sources for TSP and

SO_2 and the reactive nature of NO_2 and O_x, this model can provide only very crude estimates of concentrations for these pollutants. A modification of the simple roll-forward model to provide more accurate estimate of carbon monoxide concentration is discussed next.

(2) Modified Rollforward Model for CO[5]

High CO concentrations are observed primarily alongside heavily travelled streets where the major CO contribution is from local traffic. However, the simple roll-forward model assumes that the CO levels are proportional to the total CO emissions in the entire service area, thus giving undue weight to stationary source CO emissions and to vehicle emissions growth in the suburbs as compared to vehicle emissions growth on streets in the fully developed parts of urban areas where most existing air sampling sites are located. The following model mitigates these problems by giving the most weight (80 percent) to local traffic near the air sampling station and relatively less weight (20 percent) to total regional emissions.

The model divides the observed CO concentration into two parts: that attributable to local traffic, and that attributable to the entire urbanized area. Changes in emissions from each of these components are projected, and the future concentration is predicted using modified rollforward techniques. The model equations are:

$$F_t = F_l + F_u + b \qquad \text{(Eq. III-3)}$$

$$\frac{F_l}{0.8(B-b)} = \frac{P_{Ll}G_{Ll}E_{Ll} + P_{Hl}G_{Hl}E_{Hl}}{P_{Ll} + P_{Hl}} \quad \text{(Eq. III-4)}$$

$$\frac{F_u}{0.2(B-b)} = \frac{P_{Lu}C_{Lu}E_{Lu} + P_{Hu}G_{Hu}E_{Hu} + P_{Su}G_{Su}E_{Su}}{100\%}$$

(Eq. III-5)

where:

F_t = Total future CO concentration

F_l = Future concentration attributable to local traffic

F_u = Future concentration attributable to urban emission

b = Background concentration

B = Baseline concentration (measured or estimated)

P_L = Percent emission from light-duty vehicles (gross vehicle weight <6000 lb)

P_H = Percent emission from other mobile sources (gross vehicle weight >6000 lb)

P_s = Percent emission from stationary sources

G = Growth factor over the projection period

E = Expected ratio of future emission to baseline emission for a composite source

Note: Subscript l is for traffic on local streets near critical air sampling stations.

Subscript u is for traffic in the general urban area.

The information needed to apply the equations is discussed in Appendix E.

(3) Miller-Holzworth Model

The Miller-Holzworth model is more sophisticated than the rollforward models because it considers meteorological conditions in the study area. The model relates pollutant concentrations to emissions and meteorological conditions through an integration of a Gaussian type dispersion model; the integration is performed across an urban area.[4] The Miller-Holzworth model is expressed as:

$$X/Q = 3.613H^{0.130} + \frac{S}{2HU} - \frac{0.088UH^{1.26}}{S}$$

$$\text{for } S/U \leq 0.471H^{1.130} \qquad \text{(Eq. III-6)}$$

where: X = Average city-wide concentration, mg/m^3

Q = Average emission density, $mg/sec\text{-}m^2$

H = Mixing depth, m

S = Along-wind distance of the city, m. When this is not known, assume $S = \sqrt{area}$. The "area" is the urbanized portion of the city.

U = Average wind speed, m/sec

In cities in which $S/U < 0.471\ H^{1.130}$, mixing depth is unimportant, and X is given by

$$X/Q = 3.994\ (S/U)^{0.115} \qquad \text{(Eq. III-7)}$$

The Miller-Holzworth model is applicable to estimating annual as well as one-hour average concentrations of sulfur dioxide and particulates. A discussion of the dispersion model and appropriate seasonal average mixing heights and wind speeds is given in EPA publication AP-101.[6] This publication also provides median, upper quartile and upper decile (X/Q) values for various city sizes. Thus a range of pollutant concentrations can be estimated for the more restrictive meteorological dispersion conditions. However, neither the emissions inventory used as input nor the output of the dispersion model makes it possible to estimate spatial variations in pollutant concentrations across the area.

Although this is a simple model to use its reliability is questionable. A calibrated version of this model is available.[40] However, when applied to the two test areas discussed in Chapter V, the predicted TSP and SO_2 levels using both the original and the calibrated models did not correlate well with the observed data.

(4) Hanna-Gifford Model

The Hanna-Gifford model is used to estimate an average concentration for any defined area. In its simple form it is expressed as:[7]

$$X = CQ/U \qquad \text{(Eq. III-8)}$$

where: X = Concentration, mg/m^3

Q = Average emission rate per unit area, $mg/sec - m^2$

U = Mean wind speed, m/SEC

C = A constant whose value depends upon the pollutant

This model applies to stable pollutants such as SO_2 and TSP and can be used to estimate their annual average concentration. The values of C were determined by correlating the observed data in a large number of areas with the values predicated by the model, and were found to be 225 for TSP and 50 for SO_2.

The model is basically applicable to areas where there is no point source information available so that all emissions are grouped into area source emissions. However, the reliability of the model under such circumstances is questionable. The accuracy of the model can be increased by applying it to area sources only. The point sources can be separately modeled by using appropriate point source models such as ADQM or CDM. The total pollutant concentration is then determined by adding the point and area source contributions.

A more sophisticated form of the Hanna-Gifford model is available to estimate one-hour as well as 24-hour average concentrations from area sources. This model requires detailed meteorological data input, including hourly wind speed, wind direction, and atmospheric stability.[4]

(5) Air Quality Display Model (AQDM)

The AQDM is a computerized urban dispersion model, primarily used to determine annual or seasonal concentration of SO_2 and TSP.[8] It is capable of calculating concentrations at multiple receptor points by considering the contribution of a large number of point and area sources.

The contribution from each point and area source to a receptor point is calculated separately. For point sources, the standard Gaussian diffusion model with Holland's plume rise formula is used.[9] An option to use Brigg's plume rise formula is also available. The ADQM uses a modification of the virtual point source method for area sources.

The AQDM input requirements include detailed point and area source emissions as well as meteorological data. The point source data include location, emission rate, stack height and diameter, and temperature and velocity of gases leaving the stack for each point source. The area source data include emission rate, area, and average stack height for each area source. The meteorological data include a joint frequency distribution of six classes of wind speed, sixteen sectors of wind direction, and five classes of atmospheric stability. In addition, an average annual or seasonal mixing height is also required.

Since the AQDM calculates the contribution for point and area sources separately, it can also be used as a point or area source model only. A feature of the AQDM is that it retains a separate data file containing individual source contributions to concentrations at each receptor point. Such information is useful in developing a control strategy.

The AQDM is more accurate than the simple models discussed earlier. However, there are certain limitations to its use. It can only be sued for stable, nonreactive pollutants such as SO_2 and TSP. It can provide reliable results only for long-term average concentrations. A method developed by E. I. Larsen based on statistical analysis of observed data, is available to obtain short-term average concentrations from long-term average.[10] However, the accuracy of this method is questionable. The AQDM is developed for relatively flat terrain and modifications for complex terrain are not available. However, the model can be calibrated with observed data to account for effects of complex terrain.

(6) Climatological Dispersion Model (CDM)

The CDM is similar to the AQDM in many respects. The principal difference between the two is the method used for calculation of the area source contribution. The CDM uses the narrow plume hypothesis to calculate the impact of area sources.[11] This method is regarded to be more accurate than the virtual point source method used in the AQDM. The CDM also assumes that the wind speed varies with altitude according to a power law. Plume rise in the CDM is calculated by using Brigg's formula.[12] The input requirements for the CDM are the same as those for the AQDM. However, the individual source contributions are not readily available in the CDM. The CDM has the same limitations as those for the AQDM, but it takes approximately seventy-three percent of the computer running time for the AQDM.[11]

(7) Fast Air Quality Model (FAQM)

The FAQM was developed by the Texas Air Control Board and is conceptually similar to AQDM and CDM.[12] The input requirements for the FAQM are identical to those for the CDM, and its accuracy is comparable to that of the CDM. However, the FAQM requires about eighty times less computer running time than the CDM. The major time-saving feature of the FAQM is the method used for calculating point-source contribution. A separate program was run, which solved the Gaussian plume equation for many combinations of effective source height and downwind distance in each stability class. The results are incorporated into the FAQM as a table of coefficients for each source-receptor configuration, the FAQM interpolates in the table instead of solving the Gaussian plume equation explicitly.

Another major time-saving difference between the CDM and FAQM involves the calculation of concentrations due to area sources. Area source concentrations are determined using the simple technique of Hanna and Gifford,[7] whereby concentration is proportional to emission rate per unit area at the receptor divided by the surface wind speed. This is the only major conceptual departure from the CDM. As the behavior of diffuse pollution sources is not well understood, it is possible that the Hanna-Gifford model is a better simulation for low diffuse sources than the more complex Gaussian plume approach of the CDM.

A third time-saver is the FAQM's treatment of the meteorological joint frequency function. An average wind speed independent of wind direction is calculated for each stability class. Within a stability class, the spread in wind speed is typically small, and wind speed is a weak function of wind direction, so the simplification seems justified. Several other concentrations of three pollutants at once, compared to two for the CDM. Five different sets of meteorological conditions and emissions data for a given area may be modeled in one run to the FAQM. This capability was included to allow four seasons and annual weather and emissions to be run simultaneously for climatological studies, though other applications are possible. The FAQM is "self-calibrating." It is capable of performing a first-order least squares regression analysis of observed vs calculated concentrations. It then applies the resulting coefficients to the calculated concentrations, thus "calibrating" the model. Concentrations are calculated for a uniform grid of receptors of no more than 50 rows and 50 columns (thus a maximum of 2500 receptors) of any dimensions and spacing.

The FAQM is applicable only to estimating long-term average concentrations of SO_2 and TSP in an area with relatively flat terrain. The program documentation is available from the Texas Air Control Board.[14]

(8) Other Air Quality Models

This section presents a brief summary of other atmospheric simulation models available for urban air quality analysis.

For a detailed analysis of urban carbon monoxide concentration, two computerized models are available. The HIWAY model is a line source model applicable to motor vehicle emissions along highways and streets.[15]

The APRAC-1A model, on the other hand, considers both the line and area sources of automotive pollutants.[16].

The reduction in the hydrocarbons emissions necessary to attain the national ambient photochemical oxidants standard in an urban area can be approximately estimated by using the Appendix-J method.[17] A photochemical dispersion model called the SAI model has been developed to estimate the regional concentration of the photochemical oxidants.[18] This program is not yet available for general use.

For estimating the hourly average concentration of SO_2 and TSP, a computerized model called the sampled chronological Input Model (SCIM) has been developed.[19] Its reliability has not been widely determined, and it is not yet available for general use.

* * * *

It is clear from the above discussion that a simple but accurate method for urban air quality analysis is not available. The accuracy of the air quality analysis depends upon adequate consideration of the various factors affecting the air quality. The simpler air quality models ignore some of these factors with subsequent loss of accuracy. The more complex atmospheric simulation models provide more accurate results than the simpler models because they consider individual point and area source emissions and the local meteorological conditions. The simple Hanna-Gifford model, when used with small areas, can estimate the contribution from area sources with reasonable accuracy. However, there is no simple method for estimating the contribution from point sources to ambient air quality. The sophisticated computer models must be used for obtaining accurate and reliable results from an air quality analysis.

A simple screening procedure using the rollforward models can be developed to identify proposed wastewater projects in an AQMA with potential for causing violation of the ambient air quality standards as discussed in the next chapter.

IV. PROPOSED METHODOLOGY TO SCREEN WASTEWATER PROJECTS FOR ADVERSE SECONDARY AIR QUALITY IMPACT

This chapter presents a simple methodology for the use of both the EPA and the construction grant applicant to screen proposed wastewater projects in an AQMA, and identify those projects with potential for causing violation of ambient air quality standards. The projects with potential air quality problems should then be further analyzed using appropriate computer models as described in the previous chapter.

The proposed methodology is based on the use of the proportional rollforward models discussed in the previous chapter. Although the accuracy of these models is questionable, they can provide conservative estimates of future air quality, provided existing air quality data are available at the receptor point, where the worst air quality in the study area is expected.

The simple rollforward model implicitly assumes that the future emissions increases in the study area would be distributed such that each existing emission source would experience the same percentage increase as the total emissions in the study area. For example, if the total emissions in the study area are expected to double in the next ten years, each existing emission source in the study area would be assumed to double its emission rate. Therefore, the average ambient air pollutant concentration less the natural background at any receptor point in the study area would increase by the same percentage. Since the worst air quality is most likely to be observed in the most developed parts of the study area with little scope for additional development, the rollforward technique based on the worst air quality data is likely to overestimate the future air pollutant concentration. It, therefore, can serve as a screening tool for most pollutants, including SO_2, TSP, NO_2, and HC.

In the case of CO, the modified rollforward model provides more accurate results. However, the simple rollforward model is recommended in the proposed methodology as a preliminary screening procedure. If the simple model indicates a violation of the ambient CO standards, then the modified rollforward model should be used as described in Appendix E.

Simple methods to evaluate the impact of urban growth in a small area, such as a typical wastewater project service area, on the ambient concentration of photochemical oxidants are not available. Therefore, the EPA does not expect the grant applicants for wastewater projects, located in an AQMA for photochemical oxidants, to analyze their projects' impact on the ambient photochemical oxidants levels. However, such grant applicants are expected to evaluate the impact of their projects on the regional hydrocarbons emissions, which take part in the formation of photochemical oxidants. The proposed methodology, therefore, includes methods to estimate the impact of urban growth on the hydrocarbon emissions.

The proposed methodology involves the following steps:

- Define the impacted area
- Estimate the base year emissions for this area

- Project the emissions to the desired year

- Obtain the base year air quality data

- Project the air quality to the desired year using the Equation (III-2)

- Evaluate the Air Quality Impact of the proposed project.

- Estimate cumulative Air Quality Impact of Multiple Wastewater Projects in the same AQMA.

1. DEFINE THE IMPACTED AREA

When only area sources and small point sources are involved and photochemical oxidants are not a problem, the air quality impact of urban growth in the service area of a wastewater project is generally localized. The effect of such urban growth in adjacent areas on the air quality in the service area and vice versa should be negligible. Therefore, in such cases, the project service area is defined as the impacted area.

When large point sources such as power plants are present, the impact of their emissions may be felt over an area larger than the wastewater service area. In such cases, point sources outside the service area may have to be considered in estimating the air quality in the service area.

Photochemical oxidants are formed by a complex set of reactions involving hydrocarbons, nitrogen oxides, and sunlight. They are formed away from the source of emissions and present a regional problem. As mentioned earlier, the grant applicants are not expected to evaluate the impact of their projects on the ambient photochemical oxidants. Only the impact of urban growth in the project service area on the HC emissions should be estimated.

2. ESTIMATE BASE YEAR EMISSIONS

The most recent year for which the best local ambient air quality data are available should be selected as the base year.

The procedure for preparing an emissions inventory consists of first identifying the air pollutant emission activities and then quantifying the emissions. The emission activities can be divided into five broad classes:

- Stationary fuel combustion
- Industrial processes
- Solid waste disposal
- Transportation
- Miscellaneous (e. g., forest fires, agricultural burning, etc.)

Each of the above classes can be further subdivided according to the type of sources. For example, the stationary fuel combustion category can be divided into residential, commercial/institutional, industrial, and utility fuel. These sub-categories can be further divided according to the type of fuel used (e. g., coal, oil, and gas). Finally, each source can be classified as a point or area source. A point source represents a large emission source, typically emitting over one hundred tons of an air pollutant per year (e. g., a large fossil fuel fired power plant). An area source, on the other hand, represents a combination of small and diffuse emission sources such as houses with individual oil or gas fired heating furnaces. Motor vehicles travelling on a roadway represent a line emission source, but can be included in the area source category. For the screening procedure, the emissions activities are grouped into the following categories:

- Fuel combustion
  - Residential (area)
  - Commercial/institutional (point and area)
  - Industrial (point and area)
  - Utility (point)
- Industrial processes (point and area)
- Solid waste (point and area)
- Transportation (area)
  - Light-duty and heavy-duty motor vehicles
  - Aircrafts
  - Railroads
  - Off-highway vehicles
- Miscellaneous

The emissions for the service area are estimated by considering the point and area source emissions separately.

As discussed in Chapter III, the service area emissions from the various categories can be estimated in two ways. The most accurate way is to estimate the emissions directly, and it should be followed, if sufficient data can be obtained. The allocation method is less accurate, but if recently updated county emissions data are available, it can provide reasonable accuracy in allocating the county-wide emissions from some source categories to the service area. The method discussion below is a combination of the two methods, providing greater accuracy than the allocation method but requiring less effort than the direct estimation method.

The procedure for estimating the base year is described below in two parts: point source emissions; and area source emissions.

(1) <u>Estimate Point Source Emissions</u>

The point source emission data for the service area may be obtained directly from the point source emission file maintained by the State Air Pollution Control Agency.

If the state emission file is not complete, large emissions sources in the service area should be contacted directly to obtain the emissions data. Volume 7 of the Guidelines for Air Quality Maintenance Planning and Analysis[2] should be consulted for this purpose.

If a large point source is located outside the service area but there is a reason to believe that it has significant impact on the air quality in the service area, the emissions from the source should be included in the inventory.

(2) Estimate Area Source Emissions

The area source emission, in the service area, in general, can be estimated with reasonable accuracy by allocating the countywide emissions to the service area. However, if sufficient data are available, the service area emissions from certain source categories should be directly estimated. The methods for estimating emissions from the various source categories are discussed below.

1. Residential and Commercial/Institution Fuel and Solid Waste

The fuel use for residential and commercial/institutional purposes and solid waste generation are approximately proportional to the population. Therefore, residential and commercial/institutional fuel and solid waste emissions in the service area are estimated by allocating county emissions according to the fraction of the county population residing in the service area. More sophisticated allocation methods are described in the EPA guidelines,[(1)] and may be used if sufficient data are available.

2. Industrial Fuel

Industrial fuel use may be assumed to be proportional to the industrial employment or land use. The countywide industrial fuel emissions, therefore, are allocated to the service area according to the ratio of industrial employment in the service area to that in the county. If data on industrial employment are not available, industrial land use may be used for the allocation purpose. For more sophisticated methods, the EPA guidelines[(1)] should be consulted.

3. Industrial Processes

Industrial process emissions depend upon the type of process and size of the facility, and therefore, should be allocated by locating individual industrial sources in the service area. If sufficient data are not available, allocation based on industrial employment or land use, as explained above, should be made.

4. Motor Vehicle Emissions

Motor vehicles emit significant quantities of CO, HC, and NO_x and relatively small quantities of SO_2 and particulates. Motor vehicles form the largest source of CO, HC, and NO_x emissions. The motor vehicle emissions depend upon the vehicle type, age, speed, and operating conditions and number of vehicle miles travelled (VMT).

Motor vehicles are generally divided into five classes:

- Light duty vehicles (LDV): automobiles

- Light duty trucks (LDT): gross weight up to 8500 lbs

- Heavy duty gasoline vehicles (HDG): gross weight over 8500 lbs

- Heavy duty diesel vehicles (HDD): gross weight over 8500 lbs

- Motorcycles.

The procedure for estimating the emissions from each of the above classes involves the following steps:

- Determine the VMT for each class

- Determine the emission factor per VMT for each class averaged over different vehicle age, speed, and operating conditions

- Multiply the VMT for each class by the average emission factor.

The methods for estimating the service area VMT are given in Appendix B. The Level 3 method is the most accurate, followed by Level 2 and Level 1. The choice of the method depends upon the availability of data. If sufficient data are available, Level 3 should be used, otherwise Level 2 or Level 1 may be used in decreasing order of preference. If local data for VMT for each vehicle class cannot be obtained, national statistics may be used to divide the total service area VMT among the various classes as follows:[20]

LDV:	80.4%
LDT:	11.8%
HDG:	4.6%
HDD:	3.2%

The motorcycle emissions are usually very small and, therefore, may be ignored.

The methods to estimate the emission factors for each vehicle class are given in AP-42.[20] If local data on vehicle age, speed, and operating conditions are not available, the national statistics given in AP-42 may be used.

The total motor vehicle emissions are obtained by multiplying the VMT for each vehicle class by the corresponding emission factors and summing the products for each class. If local data on VMT as well as emission factors for each class cannot be obtained, the total emissions may be obtained by multiplying the total VMT by the national average emission factors given in Table 7-1 of AP-42.[20]

The above procedure applies to all air pollutants. However, the TSP and SO_2 emissions do not vary significantly with the vehicle type, age, speed, and operating conditions. Also, the total TSP and SO_2 emissions in the service area do not depend as strongly on the motor vehicle emissions as the other pollutants. Therefore, simpler estimation methods may be used, if only TSP and SO_2 emissions are to be estimated. Such methods include estimating the total service area VMT and using average emission factors to calculate the emissions, or allocating the countywide emissions to the service area based on VMT or population ratios.

5. Aircraft, Railroad, and Off-highway Vehicle Emissions

Aircraft and railroad emissions primarily occur near airports and railroad yards respectively. Therefore, they are allocated according to the location of the airports and railroad yards.

Off-highway vehicle emissions are usually small compared to the other categories and may be allocated based on judgment.

6. Miscellaneous Emissions

Miscellaneous sources include those not included in the above categories (e. g., fugitive dust, forest fires, agricultural burnings, gasoline marketing). Miscellaneous emissions are allocated by reviewing the type of activity and using an appropriate parameter such as population, land use, or employment.

Once the point and area source emissions are estimated, they are added to obtain total emissions for each category as well as the total for all categories.

3. PROJECT EMISSIONS

The purpose of this step is to determine emissions in the year corresponding to the "worst case" conditions in the service area. The emissions from some categories are projected by multiplying the base year emissions by appropriate growth factors such as population growth. The emissions from other categories are projected by detailed examination of the existing and future emissions activities. The emission projection procedure for each category is explained below.

(1) Residential and Commercial/Institutional Fuel

Residential and commercial/institutional fuel emissions can be projected by using the equation:

$$Q_P = Q_B \times G \qquad \text{(Eq. IV-1)}$$

where:
Q_P = Projected emissions
Q_B = 1975 emissions
G = Growth factor

The growth factor is assumed to be the same as the population growth ratio for the service area for the given period. Industrial fuel emissions can be projected by using Equation IV-1, with the growth factor equal to the ratio of industrial employment in the projection year to that in 1975 for the Standard Metropolitan Statistical Area (SMSA) in which the service area is located. If industrial employment data are not available, manufacturing earnings data may be used. The projections for the SMSA's are given in OBERS projections.[21] If the service area is not located in an SMSA, similar projections are given for larger economic areas.[22]

(2) Utility Fuel Combustion

Information on expansion of existing power plants or addition of new power plants may be obtained by contacting the utility companies. Another source of information is the Federal Power Commission, which requires the utilities to document their expansion plans on the FPC Form 67. To project emissions, determine the amount of electricity to be generated by powerplants located in the service area,* and which fuels will be burned and their quantities used in a year. Estimate the emissions from the known sulfur and ash content of each fuel, and using the emission factors given in AP-42.[20]

(3) Industrial Processes

To project the industrial process emissions, the industrial sources in the service area should be contacted individually to determine their expansion potential. Local planning boards should also be contacted

---

* Or in adjacent areas if it is determined that the power plant emissions would have significant impact on the air quality in the service area.

to estimate the location and type of potential new sources. Once the existing source expansion data are obtained, the emission factors given in AP-42 are used to project future emissions. To project the emissions from new sources, the procedure given in "Accounting for New Source Performance Standards in Projecting and Allocating Emissions"[23] should be used.

If sufficient data are not available, the emissions from industrial processes may be projected by using the following equation:

$$Q_P = Q_B G E \qquad \text{(Eq. IV-2)}$$

where:
- Q_P = Emissions for the projection year
- Q_B = Base year emissions
- G = Growth factor
- E = Emission adjustment factor

The growth factor is assumed to be equal to the ratio of the service area industrial employment in the projection year to that in the base year. If the industrial employment data are not available, the growth in the manufacturing earnings may be used to estimate the growth factor. The manufacturing earnings for the SMSA are given in the OBERS projections.[21]

The emission adjustment factor represents the reduction in emissions expected from emission control regulations on new sources. Unless more specific data are available, E = 0.4 is recommended.[5] If sufficient data are available, the procedure given in Reference (2) is recommended.

(4) Motor Vehicle Emissions

The motor vehicle emissions can be projected using the same methods used for estimating the base year emissions. The methods to project the VMT are given in Appendix B,. whereas the methods to estimate future emission factors are given in AP-42.[20]

(5) Aircraft, Railroad, and Off-highway Vehicle Emissions

The growth in these transportation activities is generally proportional to the increase in the economic activity in the area. The economic activity can be related to the total earnings in the area. Therefore, the emissions from these transportation sources can be projected by multiplying the base year emissions by the ratio of total earnings for the SMSA in the projection year to those in the base year. Total earnings are given in the OBERS projection.[21]

(6) Solid Waste

The amount of solid waste generated in a community is usually proportional to the population. Therefore, solid waste emissions can be projected by multiplying the base year emissions by the population growth factor.

(7) Miscellaneous

The miscellaneous source emissions should be projected by reviewing the type of emissions and applying an appropriate growth factor to the base year emissions.

The emissions for each category should be added to obtain the total emissions for the projection year.

4. DETERMINE BASE YEAR AIR QUALITY

Depending on the pollutants for which the area has been designated as an AQMA, the required air quality data for comparison with the NAAQS vary as described in Table IV-1. The air quality in the service area should be determined from air quality monitoring conducted in the service area by state or local air pollution control agencies. If there are more than one monitoring stations in the service area, the highest concentrations among the various monitoring sites should be used. If there are no monitoring stations in the service area, data from monitoring stations located in nearby areas may be used, provided that the emission sources and mix, topography, and meteorological conditions in those areas are representative of those in the service area. If representative monitoring data are not available, the grant applicant should contact the Air Branch of the EPA's regional office.

5. PROJECT AIR QUALITY

In the simple methodology, it is assumed that the ambient concentration less the background concentration of an air pollutant in an area is proportional to the amount of that pollutant emitted in that area. The projected pollutant concentration is given by the following equation:

$$X_{PN} = b_N + (X_{BN} - b_N) \frac{Q_{PN}}{Q_{BN}} \quad \text{(Eq. IV-3)}$$

Table IV-1
Air Quality Data Requirements
for the Base Year

Pollutant	Averaging period
Sulfur dioxide	3-Hour (second highest)
	24-Hour (second highest)
	1-Year (arithmetic mean)
Particulate matter	24-Hour (second highest)
	1-Year (geometric mean)
Nitrogen dioxide	1-Year (geometric mean)
Carbon monoxide	1-Hour (second highest)
	8-Hour (second highest)

where: X_{PN} = Projected concentration of pollutant N

X_{BN} = Base year concentration of pollutant N

b_N = Background concentration of pollutant N

Q_{PN} = Projected emissions of pollutant N

Q_{BN} = Base year emission of pollutant N

The background concentration of SO_2 and NO_2 is assumed to be zero, while that of particulate matter is determined from available data from the state or local air pollution control agencies. For carbon monoxide, background concentration of 1 ppm of 8 hours[5] and 5 ppm for 1 hour[24] is assumed. As mentioned before, it is not necessary to project the oxidants concentration for the screening purposes.

6. EVALUATE THE AIR QUALITY IMPACT OF THE PROPOSED PROJECT

After the future air quality levels are projected, they must be compared with the applicable ambient air quality standards. If the standards are met, no further air quality analysis is necessary. If a violation of the standards is indicated, further analysis as shown in the Decision Flow Diagram in Chapter II would be required. However, if a violation of the CO standards is indicated, the modified rollforward model for CO described in Chapter III and Appendix E should be applied first. If the modified rollforward model also indicates a violation, the next step in the decision flow diagram should be taken.

7. ESTIMATE CUMULATIVE AIR QUALITY IMPACTS OF MULTIPLE WASTEWATER PROJECTS IN AN AQMA

When only area and point sources are present and photochemical oxidants are not a problem, the cumulative air quality impacts of several wastewater projects in the same AQMA would be negligible, because such impacts are generally localized.

When large point sources are present, they should be included in the air quality analysis as discussed in Section 1, Subsection (1) of this Chapter.

The photochemical oxidants present a regional problem and must be analyzed on a regionwide basis. Such an analysis would be beyond the scope of a wastewater project grant applicant. However, the grant applicant should estimate the contribution of his service area's growth to the regional HC emissions by using the methods discussed in Sections 2 and 3 of this Chapter.

V. STUDY OF TWO TEST PROJECTS

In order to aid in the development of the proposed methodology and to test it, the EPA selected two test projects in the State of New York, involving expansion of wastewater collection and treatment facilities in:

- Town of Colonie
- Rockland County Sewer District Number 1

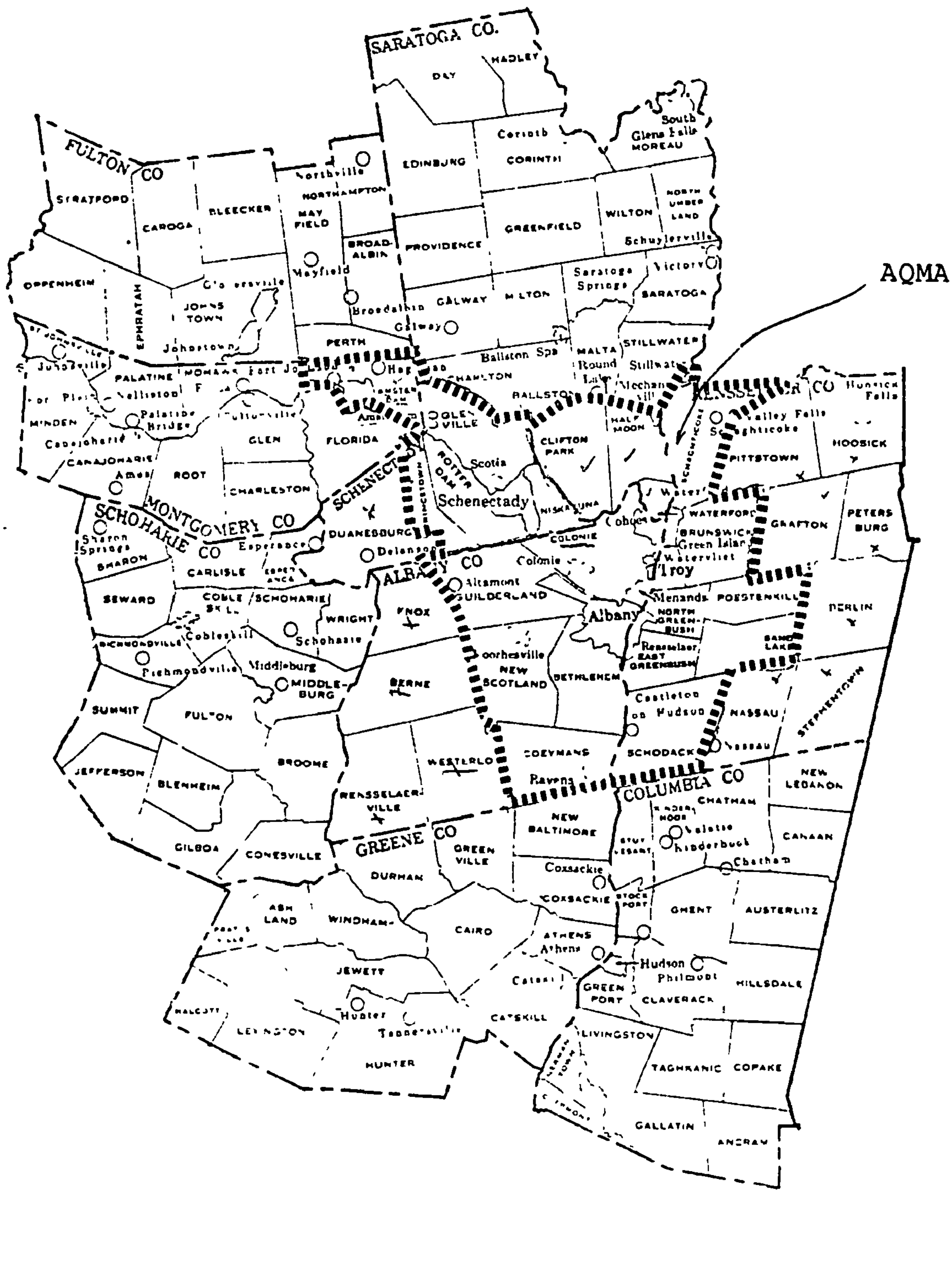
The two projects were selected because they are located in AQMAs for different pollutants and both indicated high urban growth potential. The application of the proposed methodology to assess the secondary air quality impact of the two projects is described below. This methodology is equally applicable to any wastewater project in the U.S.

1. TOWN OF COLONIE

The Town of Colonie is located in Albany County, New York. It is included in the Capital District AQMA, which is an AQMA for total suspended particulates and sulfur dioxide. Figure V-1 shows the boundary of the Capital District AQMA.

The topography of the region is generally rolling. The prevailing wind direction is from the south and the average wind speed is 8.2 mph.[25]

FIGURE V-1
Capital District AQMA



Major air pollutant emission sources in the AQMA include large manufacturing and chemical industrial plants, an electric generating station, heating plants for hospitals, colleges, and schools, and a paper mill.

Because of the state air pollution control regulations ambient air quality in the AQMA has improved over the past five years and the ambient air quality standards are being met in most parts of the AQMA, except in the City of Albany. The annual TSP levels in the Town of Colonie decreased from 55 micrograms per cubic meter in 1973 to 51 micrograms per cubic meter in 1974.[26] Although the TSP levels in Albany have decreased, the AAQS for TSP were violated in 1974. Similarly, the sulfur dioxide standards were exceeded in Albany while they were being met in the other areas. Ambient concentrations of the other pollutants in the AQMA were below the applicable AAQS.

Although the existing TSP and SO_2 levels in the Town of Colonie are below the AAQS, a rapid urban expansion in the area may create a potential for violation of the AAQS in the future. The strategic location of the Town in relation to the industrialized City of Schenectady and the State Capital Albany makes it an attractive area for residential and associated commercial development. The proposed wastewater project in the Town of Colonie was designed in 1969 based on this growth potential.

The proposed project (EPA Grant Application Numbers C-36-742 and C-36-781) includes construction of lateral sewers, trunk and intercepting sewers, pumping stations and treatment facilities within the Town of Colonie as shown in Figure V-2. The service area of the proposed wastewater

PAGE NOT

AVAILABLE

DIGITALLY

project encompasses the Town of Colonie excluding the Villages of Colonie and Menands and certain other areas as shown in Figure V-2. The service area is divided into two parts: Mohawk River watershed area and Hudson River watershed area. The total service area is approximately 12,750 hectares (31,500 acres). The wastewater from the Mohawk River watershed will be conveyed to the proposed 18,925 cu m/day (5 mgd) capacity treatment plant to be located along the Mohawk River.[28] The wastewater from the Hudson River watershed will be conveyed to the 132,475 cu m/day (35 mgd) treatment plant in Albany.[29] Approximately 18,000 cu m/day (7.4 mgd) capacity of the Albany plant is assigned to the Town of Colonie.

Total population of the service area in 1970 based on the 1970 census was 57,863 with 20,425 in the Mohawk River watershed area and 37,438 in the Hudson River watershed area. The design of the treatment plant in the Mohawk River watershed area is based on a population of 35,500 in 1990 as projected in 1969.[28] The sewers in that area are designed for a 50-year projected population of 61,000. The sewers in the Hudson River watershed area are designed for a 50-year projected population of 79,000.[30] while the portion of the Albany treatment plant assigned to the Town of Colonie is designed for a projected population of 52,540 in 1990. Thus, the total design population to be served by the proposed wastewater treatment facilities in 1990 in the Town of Colonie is 86,900. The estimated population in 1975 is 71,000.[31]

The population projections for New York State as well as the Capital District Metropolitan area have been considerably reduced.[32] The latest projection for the service calls for a population of 80,000 by the year 2000. Thus, the estimate of design population of 86,900 to be reached in 1990 is highly conservative. The secondary air quality impact assessment of the proposed project discussed below is based on this estimate and, therefore, represents the "worst case" analysis.

The study area for the air quality analysis consists of the proposed project service area. The year 1975 was selected as the base year and 1990, when the design population of the treatment facilities was expected to be reached, was selected as the projection year.

The various steps in the proposed methodology are applied to the proposed project as described below:

- Estimate base year emissions
- Project future emissions
- Determine base year air quality
- Project air quality
- Compare projected air quality with AAQS.

(1) Estimate 1975 Emissions

The procedure for estimating TSP emissions is explained below. Similar procedure applies to estimating SO_2 emissions.

The first step in estimating the 1975 emissions is to obtain individual point source emissions from the New York State DEC. The DEC maintains a data file for significant point sources which have a potential to emit in excess of one hundred tons per year of any air pollutant. However, because of emission controls, these sources generally emit less quantities. The point source TSP emission for Albany County as well as for the Town of Colonie are shown in Table V-1. The DEC data file contained total emissions for each point source. The industrial point source emissions were, therefore, separated into fuel and process emissions by using the same proportion as in the County point source emissions discussed below.

The next step is to estimate the area source emissions. These were estimated by allocating the county emissions to the service area. The emissions data for Albany County were obtained from the New York State Implementation Plan prepared by the Department of Environmental Conservation (DEC).[33] Table V-2 shows the estimated point and area source TSP emissions in 1975 for the various source categories. These emissions are estimates only, and should not normally be used, if actual data are available.

There are some differences between the point source emissions data shown in Table V-1 and Table V-2. Since Table V-1 contains more recent data, some adjustments were made to the county emissions data. The significant countywide Commercial/Institutional fuel point source emissions were subtracted from the total countywide Commercial/Institutional fuel emissions to obtain the county area source emissions. The significant industrial point source emissions were separated into fuel and process emissions in the same proportion as that for the total industrial point source emissions given in Table V-2. The countywide industrial fuel and process area source emissions were then obtained using the same procedure

Table V-1
Significant TSP Point Source Emissions
In Albany County and Town of Colonie, 1975

Source Category	Emissions (tons/year) County	Service Area
Commercial/Inst. Fuel	149.83	11.34
Industrial Fuel*	140.4	8.4
Utility Fuel	1932.00	-
Industrial Processes*	1263.6	74.6
Solid Waste	-	-
Total	3485.83	94.34

* Assumed to be in the same proportion of the total industrial point source emissions as in Table V-2

Source: New York State Department of Environmental Conservation, Division of Air Resources, Albany, New York

Table V-2
Estimated TSP Emissions in Albany County, 1975

Source Category	Emissions (tons/yr) Point	Area	Total
Residential Fuel		599	599
Commercial/Inst. Fuel	17	516	533
Industrial Fuel	334	209	543
Utility Fuel	1,932	-	1,932
Industrial Processes	3,341	44	3,386
Solid Waste	0	395	395
Transportation			
Motor vehicles	-	535	535
Aircraft	-	169	169
Railroad	-	275	275
Off-highway	-	13	13
Miscellaneous	-	-	-
Total	5,624	2,755	8,379

Source: Reference (33)

described above for Commercial/Institutional Fuel category.

The revised countywide area source emissions are shown in Table V-3. These county area source emissions were then allocated to the service area by using the allocation parameters as shown in Table V-3.

(2) Project 1990 Emissions

Using the total base year emissions for each category and the growth factors* as indicated in Table V-4, the emissions were projected to 1990 as shown in Table V-4. To obtain conservative results, the growth factors were applied to both point and area source emissions instead of area sources alone. Although the industrial process emissions were projected based on the control factor of 0.4, they were assumed to remain constant in the subsequent analysis for obtaining conservative estimates. The growth factors were obtained from OBERS projection.[21]

(3) Determine Base Year Air Quality

The most recent data for the Town of Colonie were available for 1974. Normally, it would not be acceptable to use 1974 air quality data with the 1975 emissions. However, the 1974 air quality data were used in this case, because the past air quality data indicated a trend towards lower pollutant concentrations. Therefore, the projected air quality levels would be conservative.

---

* Growth factors were estimated as discussed in Chapter IV, Section 3.

Table V-3
Allocation of Countywide TSP Area Source
Emissions to Service Area, 1975
(Town of Colonie)

Source Category	County Emissions (t/yr)	Allocation Parameter Name	Allocation Parameter Ratio* %	Service Area Emissions (t/yr)
Residential Fuel	599	pop.	7.41	44.4
Comm/Inst. Fuel	383	land use or emp.	7.41+	28.4
Ind. Fuel	403	land use or emp.	7.41	29.9
Ind. Processes	2122	land use or emp.	7.41+	157.2
Solid Waste	395	pop	7.41	29.2
Transportation Motor Vehicles	535	pop	7.41	39.6
Aircraft	169	location	100	169.0
Railroad	275	location	0	0
Off-highway	13	pop.	0	0
Total	2755			497.74

* Service area to county

\+ Because of lack of data, assumed to be proportional to population.

Table V-4
TSP Emission Projections for Service Area, 1990
(Town of Colonie)

Source Category	Base Year Emissions, QB (ton/yr)	Growth Parameter	Growth Factor	Emission Control Factor	Projected Emissions, QP (ton/yr)
Residential Fuel	44.4	pop.	1.21	1.0	53.7
Comm/Inst. Fuel	39.7	pop.	1.21	1.0	48.0
Industrial Fuel	38.2	manufact. earnings	1.51	1.0	57.7
Utility Fuel	-	forecast	-	-	-
Industrial Processes	231.8	manufact. earnings	1.51	0.4	140.0 (232)*
Solid Waste	29.2	pop.	1.21	1.0	35.3
Transportation					
Motor Vehicles	39.6	pop.	1.21	1.0	47.9
Aircraft	169.0	total earnings	1.69	1.0	285.6
Railroad	-				
Off-highway	-				
Miscellaneous	-				
Total	591.9				668.2 (760.2)*

* Assuming industrial process emissions to remain unchanged.

The second highest 24-hour and 1-year average TSP concentrations in 1974 in the Town of Colonie were 119 and 51 micrograms per cu. m. respectively.[26] The natural background levels of TSP in the region are approximately 35 micrograms per cu. m.[32]

(4) Project Air Quality

Using the estimated 1975 and 1990 service area TSP emissions (Q_B and Q_P), the base year TSP concentrations (B), the background concentration (b), and the Equation (IV-3), the 1990 TSP concentrations were projected as shown in Table V-5. The table shows the expected total TSP concentration (X_P) as well as the incremental TSP concentrations (X_I). The results for SO_2 are also shown in Table V-5. The procedure followed for estimating the SO_2 concentrations was similar to that for TSP.

(5) Compare Projected Air Quality With AAQS

The projected air quality is compared with two sets of air quality standards:

- National Ambient Air Quality Standards (NAAQS) — Comparing the projected TSP and SO_2 concentrations with the applicable primary and secondary NAAQS indicates that these standards are not likely to be violated.

Table V-5
Projected Total and Incremental TSP and
SO_2 Concentrations in the Town of Colonie, 1990

Pollutant	X_B	b	X_B-b	Q_P/Q_B*	X_I	X_P
TSP						
24-Hour (second highest)	119	35	84	1.28	23.5	142.5
1-Year (geometric mean)	51	35	16	1.28	4.5	55.5
SO_2						
24-Hour (second highest)	129	0	129	1.15	19.3	148.3
1-Year (arithmetic mean)	37	0	37	1.15	5.5	42.5

X_B = base year concentration

b = background

O_P = projected emissions

O_B = base year emissions

X_P = projected concentration

X_I = projected incremental concentration

* Assuming industrial process emissions to remain unchanged.

- Nondegradation Criteria — All areas in New York State carry the initial EPA designation of Class II. Comparing the projected incremental TSP and SO_2 concentrations with the Class II requirements indicates that the nondegradation criteria would also be met.

The preceding analysis indicates that the projected urban growth in the Town of Colonie corresponding to the design population of the proposed treatment facilities is not likely to cause violation of the ambient air quality standards. The results are based on conservative estimates of population growth as well as the air pollutant emissions. As mentioned in the previous section, the population forecasts for the Albany area have been recently revised indicating much lower population growth than predicted earlier. The projected pollutant concentrations based on the revised population projections would be lower than those given in Table V-5. Thus, the proposed wastewater treatment facilities for the Town of Colonie should be approved from the air quality perspective. Since the interceptor sewers are sized for 50-year population growth, the uncertainties involved in predicting air quality impact of such long term growth would be great. The use of the excess sewers capacity depends upon the availability of additional treatment capacity. Thus, the air quality impact analysis of the urban growth corresponding to the sewer capacity should be done at the time of expansion of the treatment facilities in the future. The next section describes the air quality analysis of the Rockland County Sewer District No. 1.

2. ROCKLAND COUNTY SEWER DISTRICT NUMBER 1

Rockland County Sewer District No. 1 is included in the New York City Metropolitan AQMA, which is an AQMA for

SO_2, TSP, NO_2, CO, and oxidants. Figure V-3 shows a map of the AQMA.

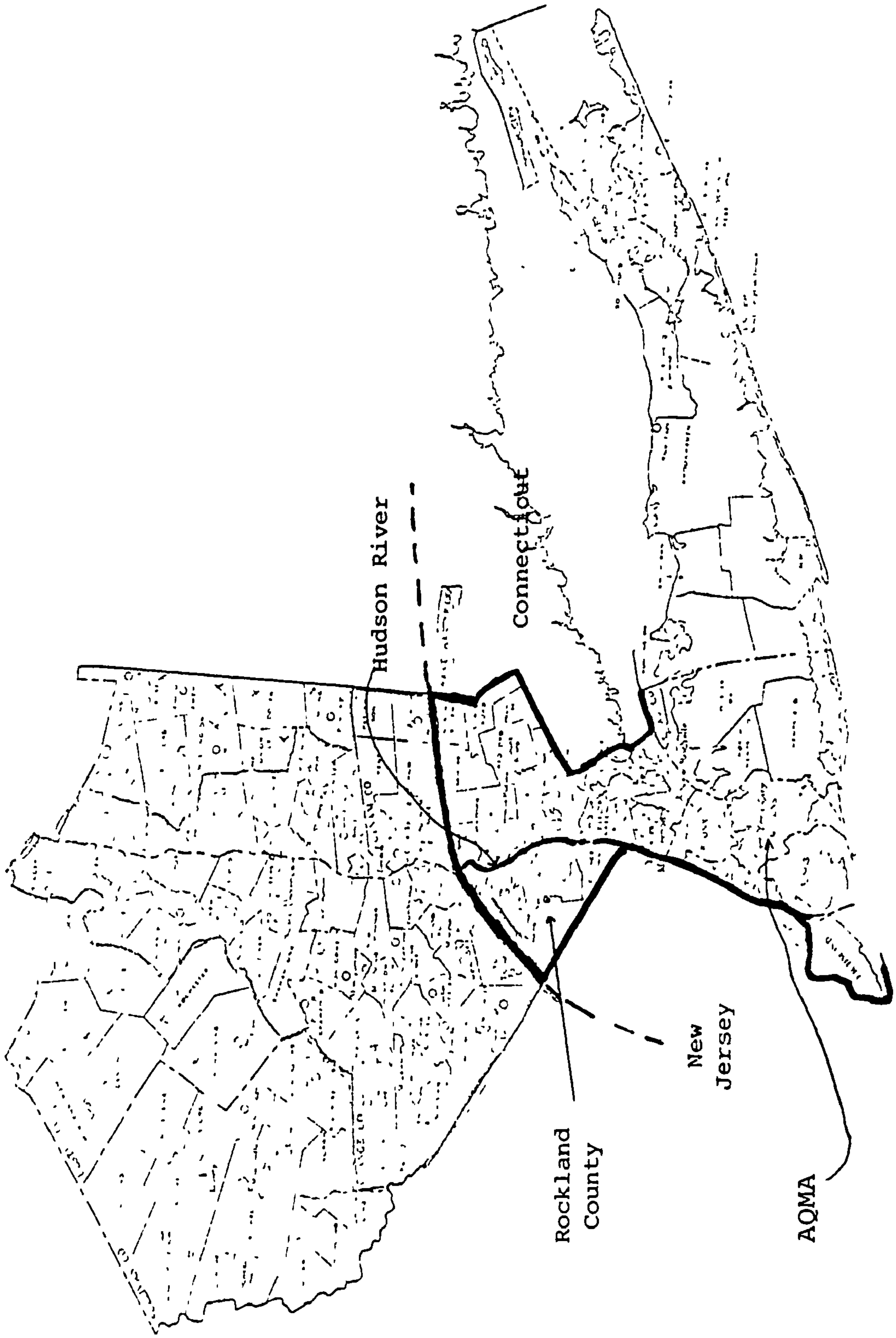
The Sewer District has a rough terrain. It is bounded by a mountain range to the east, north, and northwest. The prevailing wind is from the north and the average wind speed is about 6.8 mph.[34] Ambient SO_2 and TSP levels in Rockland County are monitored by the State DEC. These levels showed a slight improvement in 1976 over the 1973 levels. The ambient levels of SO_2 and TSP in the Sewer District were well below the ambient standards.[26]

The ambient CO, NO_2, and oxidants levels are not monitored in the Rockland County. Air quality monitors in the surrounding region indicated that the annual average NO_2 and 1-hour average CO levels in the region in 1974-75 were below the AAQS. However, the 8-hour CO and the 1-hour oxidants standards were frequently violated at most of the monitoring sites.[26]

Because of its proximity to New York City and the general trend towards moving out to the suburbs, Rockland County Sewer District No. 1 is expected to grow rapidly. Such growth would adversely affect the ambient air quality. This section analyzes the air quality impacts of the projected urban growth in the Sewer District using the screening procedure.

A map of Rockland County Sewer District Number 1 is shown in Figure V-4. The Sewer District includes most parts of the Town of Ramapo and the Town of Clarkstown as shown. The Sewer District has an area of approximately 18,103 hectares (44,670 acres).[35] The service area is predominantly residential with some light industrial and commercial

FIGURE V-3
New York City
Metropolitan AQMA



PAGE NOT

AVAILABLE

DIGITALLY

development. The New York Throughway passes through the service area in the east-west direction, while the Garden State Parkway and the Palisades Interstate Parkway are the major highways connecting Rockland County to the business districts of New York City and adjacent New Jersey.

The proposed wastewater project (EPA grant application Number C-36-744) consists of three stages.[35] The first two stages include construction of a 37,850 cu m/day (10 mgd) capacity treatment facility and sewerage system as shown in Figure V-4. Stage I has been completed while Stage II is partially completed. The proposed Stage III consists of expansion of the existing treatment plant from 37,850 cu m/day to 75,700 cu m/day (20 mgd) capacity and construction of additional sewerage as shown in Figure V-4. The additional sewerage would serve the outskirts of the Town of Ramapo and Clarkstown.

The existing and projected population for Rockland County and the project service area are shown in Table V-6.

Table V-6
Existing and Projected Population Rockland County

Year	Rockland County	Sewer District No. 1
1970	240,000	121,000
1975	270,000	144,000
1980	310,000	166,300
Maximum Land Capacity	408,500	210,700

Source: References (36) and (37).

The existing wastewater treatment facility in Sewer District No. 1 serves a population of approximately 80,000. The rest of the population in the service area is served by package treatment plants and individual septic tank systems. The proposed treatment facility is designed to serve a population of 161,680, which was the previously projected saturation population to be reached in 1985. The population projection in Table V-6 indicates that the proposed treatment plant would serve a large portion of the existing population and the design population of the plant would be reached before 1980.

The air quality analysis described below is based on the projected 1980 population of 166,300 which is slightly greater than the treatment plant design population and is considered to be the "worst case." The year 1975 was selected as the base year.

Since the New York City metropolitan area is an AQMA for TSP, SO_2, CO, NO_x, and oxidants, the impact of urban growth on the ambient concentration of each of these pollutants must be assessed. The procedure for assessing the impact is basically similar to that described in the case of Town of Colonie. However, because of the significant contribution of motor vehicles to the emissions of CO, NO_2, and hydrocarbons, it is important to obtain an accurate estimate of the motor vehicle emissions. In the following analysis, the procedure for estimating CO emissions from motor vehicles is explained in detail. Similar procedure applies to the other pollutants. The discussion of the impact analysis is organized as follows:

- Estimate 1975 emissions
- Project 1980 emissions

- Determine baseline air quality
- Project 1980 air quality

Each of the above steps is described below.

(1) Estimate 1975 Emissions

As mentioned earlier, the first step in estimating emissions is to estimate point source emissions. The major point source emissions data file for Rockland County was obtained from the New York DEC. The data for CO indicated negligible CO emissions from the major point sources within the Sewer District. The emissions from such sources within the county were also very small.

The area source emissions are determined next. The estimates for total countywide CO emissions were obtained from the SIP as shown in Table V-7.[38] The estimates indicate that over 99.5 percent of the total CO emissions in Rockland County came from motor vehicles. Because of such a significant contribution from motor vehicles, the CO emission from motor vehicles in the Sewer District are estimated directly, rather than by allocating the county emissions to the Sewer District. Since the CO emissions from the remaining sources are relatively insignificant, those can be ignored in this particular case. However, such emissions may have to be considered in other areas, using the methods given in Chapter IV.

Since the simple rollforward model will be used for an initial screening, only the total CO emissions in the Sewer District need to be determined at this

Table V-7
Estimated CO Emissions in Rockland County, 1975

Source Category	Emissions (tons/yr) Point	Area	Total
Residential Fuel	-	395	395
Commercial/Inst. Fuel	-	-	-
Industrial Fuel	-	-	-
Utility Fuel	16	-	16
Industrial Processes	-	-	-
Solid Waste	30	39	69
Transportation			
Motor Vehicles	-	91,590	91,590
Aircraft	-	-	-
Railroad	-	-	-
Off-Highway	-	-	-
Miscellaneous	-	-	-
Total	46	92,024	92,070

Source: Reference (38).

time. These emissions can be determined by multiplying the VMT in the Sewer District by an appropriate emission factor.

The Sewer District VMT were estimated using the methods described in Appendix B. The results are summarized in Appendix C. For illustration purpose, the VMT were estimated using each of the three levels of analyses given in Appendix B.

However, since the Level 3 estimate would be the most accurate, those are used in this analysis.

Because of the lack of more specific data, the CO emission factor for the Sewer District was assumed to be equal to the average emission factor based on national statistics for highway vehicles given in Table 7-1 of AP-42.[20]

The estimates 1975 CO emissions in the Sewer District are summarized below:

VMT : 747.1×10^6 per year

Emission Factor : 61.1 gm/mile

Emissions : 456.4×10^8 gm/year

(2) Project 1980 Emissions

The procedure for estimating the 1980 CO emissions is similar to that discussed above. The Level 3 VMT estimate from Appendix C, the national average emission factor from AP-42, and the estimated CO emissions are as follows:

VMT	:	870.9×10^6 per year
Emission Factors	:	31.0 gm/mile
Emissions	:	270.0×10^8 gm/year

(3) Determine Baseline Air Quality

There has been no reported monitoring of ambient CO concentration in Rockland County. Normally, it would not be acceptable to use the rollforward models without such monitoring data. However, the data for the period between January 1 to December 31, 1974 from the monitoring station at Mamaroneck in neighboring Westchester County are available and are used here for illustration purpose. The observed second-highest 1- and 8-hour average CO concentration at Mamaroneck in 1974 are as follows:[39]

1-hour	:	23.70 ppm
8-hour	:	13.2 ppm

The background CO levels are assumed to 5 ppm for 1-hour average and 1 ppm for 8-hour average as discussed in Chapter IV.

(4) Project 1980 Air Quality

The 1980 CO concentration is projected using the simple rollforward model. The estimated 1-hour and 8-hour average concentrations are as follows:

1-hour	:	16.1 ppm
8-hour	:	8.2 ppm

Since these estimates are highly conservative, and below the NAAQS, it is not necessary to use the Modified Rollforward Model.

The projection methods for NO_2, TSP, and SO_2 concentrations are similar to those described in the case of Town of Colonie. However, the emissions from motor vehicles are calculated using the VMT estimated in Appendix C and the national average emission factors given in AP-42. Using the TSP and SO_2 data from the monitoring station in Clarkstown[26] and the NO_2 data from Mamaroneck,[39] the 1980 concentrations were projected. The results are summarized in Table V-8.

Table V-8
Projected Impact on NO_2, SO_2, and TSP
Concentrations in Rockland County Sewer District No. 1

Pollutant	Emissions (t/yr) 1975	1980	Ambient Concentration (ug/m^3)	1975	1980
SO_2	492	571	24-hour*	97	113
			1-year**	14	16
TSP	433	491	24-hour*	115	125
			1-year+	50	52
NO_2	5,107	4,696	1-year**	70	64

* Second highest.
** Arithmetic mean.
\+ Geometric Mean.

Comparison of the projected concentration of CO, TSP, SO_2, and NO_2 with the corresponding National ambient air quality standards given in Table I-1, indicates that the NAAQS would not be violated. Further comparison of the projected incremental TSP and SO_2 concentrations with the nondegradation criteria given in Table II-2 indicates that these criteria would also be met. Although the 3-hour SO_2 concentration was not estimated, it may be inferred from the 24-hour and 1-hour concentrations that the 3-hour standards would also be met.

According to the discussion in Chapter IV, the impact on ambient oxidants concentration was not estimated. However, the hydrocarbon emissions were estimated as discussed below.

The estimated 1975 hydrocarbon emissions for Rockland County were obtained from the SIP and are given in Table V-9. The New York State DEC file of significant point source emissions indicated no significant point emission sources of HC in the Rockland County Sewer District No. 1. The nonmotor vehicle emission sources in the sewer district would thus contribute less than two percent to the HC emissions. The nonmotor vehicle emission sources are, therefore, ignored in this analysis.

Instead of using the county emission data, the HC emissions for the sewer district were computed using the VMT estimated earlier and the national average emission factors given in AP-42. The estimated VMT and HC emissions in 1975 and 1980 are shown in Table V-10.

Table V-9

Estimated HC Emissions in Rockland County, 1975

Source Category	Emissions (tons/yr)		
	Point	Area	Total
Residential Fuel	-	100	100
Commercial/Inst. Fuel	12	-	12
Industrial Fuel	-	-	-
Utility Fuel	895	-	895
Industrial Processes	140	100	240
Solid Waste	45	8	53
Transportation			
Motor Vehicles	-	11,648	11,648
Aircraft	-	-	-
Railroad	-	-	-
Off-Highway	-	-	-
Miscellaneous	-	-	-
Total	1,092	11,856	12,948

Source: Reference (39).

Table V-10

Existing and Projected HC Emissions in the Sewer District No. 1

	1975	1980
VMT (10^6/year)	747.1	870.9
HC Emission Factor* (gm/mile)	8.8	5.4
HC Emissions (10^8 gm/year)	65.7	47.0

* Source: Reference (20), Table 7-1

The estimates in Table V-10 indicate that the HC emissions in the Sewer District would decrease in 1980 by about 29 percent of the 1975 value. The impact of such HC reduction in the Sewer District, on the region's oxidant levels cannot be easily determined. However, the impact of the proposed wastewater project on the Sewer District's urban growth, hence on the HC emissions, can be qualitatively estimated as discussed below.

A review of the population growth and land-use patterns in the service area shows that the projected urban growth in the proposed project service area to 1980 is not likely to be dependent upon the availability of sewerage for the following reasons:

- While the proposed treatment plant together with the existing plant has a capacity to serve a total of approximately 161,000 persons, about 144,000 of them have already settled in the service area.

- There is some vacant land in the service area which if not sewered, could still be suitable for low density residential development with the use of individual septic tank systems. Such development could accommodate 17,000 more persons in the next four to five years.

Thus, construction of the proposed treatment plant is not likely to induce excessive growth in the service area. Therefore, it is not likely to have significant impact on the area's HC emissions.

The results of the preceding analysis indicate that the urban growth to be served by the proposed treatment plant is not likely to cause violation of national air quality standards for TSP, SO_2, NO_2, and CO. In addition, the proposed project is not likely to affect the area's HC emissions. Therefore, the proposed wastewater treatment facility should be approved from the air quality standpoint.

In order to evaluate the impact on the oxidants levels, a regional air quality modeling study needs to be undertaken. Such a study would identify the problem areas and would also allow testing of various control strategies to attain ambient oxidant standards in the region.

* * * * *

The above analyses of the two test projects demonstrated the application of the proposed screening procedure in Chapter IV. Although the proposed screening procedure is quite general, possible approximations in specific situations were illustrated in these applications. The application of the screening procedure conservatively estimated the secondary air quality impact of the two wastewater projects and indicated that construction of those projects would not create a potential for violation of ambient air quality standards in the respective AQMA's.

B I B L I O G R A P H Y

1. Guidelines for Air Quality Maintenance Planning and Analysis: Allocating Projected Emissions to Subcounty Areas, Volume 13, U.S. Environmental Protection Agency, November 1974.

2. Guidelines for Air Quality Maintenance Planning and Analysis, Projecting County Emissions, Volume 7, U.S. Environmental Protection Agency, January 1975.

3. Air Pollution/Land Use Planning Project, Phase II, Final Report, Volume II, Argonne National Laboratory, Center for Environmental Studies, May 1973.

4. Guidelines for Air Quality Maintenance Planning and Analysis, Applying Atmospheric Simulation Models to Air Quality Maintenance Areas, Volume 12, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, September 1974.

5. Guidelines for Air Quality Maintenance Planning and Analysis, Designation of Air Quality Maintenance Areas, Volume 1, U.S. Environmental Protection Agency, September 1974, pp 39.

6. Holzworth, G.C.; Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States; Office of Air Programs Publication No. AP-101 (NTIS PB 207103); Office of Technical Information and Publications; U.S. EPA; Research Triangle Park, N.C. 27711; January 1972.

7. Hanna, S.R., Simple Methods of Calculating Dispersion from Urban Area Sources, presented at the Conference on Air Pollution Meteorology, sponsored by American Meteorological Society in cooperation with the Air Pollution Control Association, Raleigh, N.C., April 6, 1971.

8. TRW Systems Group; Air Quality Display Model; Prepared for the National Air Pollution Control Administration under Contract No. PH-22-68-60 (NTIS PB 189194), DHEW, U.S. Public Health Service, Washington, D.C., November, 1949.

9. Turner, D.B.; Workbook of Atmospheric Dispersion Estimates; PHS Publication No. 999-AP-26 (NTIS PB 191482); Office of Technical Information and Publications, U.S. EPA; Research Triangle Park, N.C. 27711; 1969.

10. Larsen, R.I.; A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards; Office of Air Programs Publication No. AP-89 (NTIS PB 205277); Office of Technical Information and Publications; U.S. EPA, Research Triangle Park, N.C. 27711; November 1971.

11. Busse, A.D., and Zimmerman, J.R.; User's Guide for the Climatological Dispersion Model; Environmental Monitoring Series EPA-R4-73-024 (NTIS PB 227346AS) NERC, EPA, Research Triangle Park, N.C. 27711, December 1973.

12. Briggs, G.A.; Plume Rise, U.S. Atomic Energy Commission, Office of Information Services, 1969.

13. Christiansen, J.H., and Porter, R.A.; Ambient Air Quality Predictions with the Fast Air Quality Model, Texas Air Control Board, Austin, Texas.

14. Christiansen, John H., Data Processing Section, Texas Air Control Board, 8520 Shoal Creek Boulevard, Austin, Texas 78758, Phone (512) 451-5711.

15. Zimmerman, J.R., and Thompson, R.S.; User's Guide for HIWAY: A Highway Air Pollution Model; Environmental Monitoring Series EPA-650/4-008, NERC, EPA, Research Triangle Park, N.C. 27711 (in preparation).

16. Ludwig, F.L., and Mancuso, R.L.; User's Manual for the APRAC-1A Urban Diffusion Model Computer Program, Prepared for U.S. EPA Division of Meteorology Under Contract CAPA-3-68 (1-69) (NTIS PB 213091); U.S. EPA, Research Triangle Park, N.C. 27711; September 1972.

17. U.S. EPA; Requirements for Preparation, Adoption, and Submittal of Implementation Plans -- Appendix J; Federal Register 36; No. 158; p. 15502; August 14, 1971.

18. Systems Applications Inc.; Urban Air Shed Photochemical Simulation Model Study -- Volumes I - III; Prepared for U.S. EPA, ORD Under Contract Number 68-02-0339; EPA-R4-73-030q: Washington, D.C. 20460; July 1973. (Available from APTIC).

19. Koch, R.C., and Stadsklev, G.H.; A User's Manual for the Sampled Chronological Input Model (SCIM); GEOMET Report No. E-261 prepared for U.S. EPA Under Contract Number 68-02-0281; U.S. EPA, OAQPS, Research Triangle Park, N.C. 27711; August 1973. (Available in draft form only).

20. Compilation of Air Pollution Factors, AP-42, U.S. Environmental Protection Agency, April 1973. This document is continuously updated. The latest supplements to AP-42 should be used. The latest supplement for motor vehicle emissions is Number 5, April 1975.

21. 1972 OBER's Projections, Standard Metropolitan Statistical Areas, Volume 5, U.S. Water Resources Council, Washington, D.C., April, 1974.

22. 1972 OBER's Projections, Economic Activity in the U.S. BEA Economic Areas, Volume 2, U.S. Water Resources Council, Washington, D.C., April, 1974.

23. Accounting for New Source Performance Standards in Projecting and Allocating Emissions, published as an Appendix to reference 1. above.

24. Guidelines for Air Quality Maintenance Planning and Analysis, Evaluating Indirect Sources, Volume 9, U.S. Environmental Protection Agency, January 1975.

25. Seasonal and Annual Wind Distribution of Pasquill Stability Classes, Star Program, Albany, New York, (1/74 - 12/74), National Climatic Center, Ashville, N.C.

26. New York State Department of Environmental Conservation, Division of Air Resources, 50 Wolf Road, Albany, New York 12233, Private communications with Mr. William F. Eberle and Mr. William J. Bernaski.

27. Pure Waters Program, Town of Colonie, Albany County, New York, Charles T. Male Associates, January, 1969.

28. Environmental Assessment Summary for the Proposed Mohawk View Water Pollution Control Plant and Trunk Sewers, Mohawk River Watershed Area, Town of Colonie, Albany County, New York, January 1974.

29. Environmental Assessment Statement for Proposed Trunk Sewers, Hudson River Watershed Area, Town of Colonie, Albany County, New York, January, 1973.

30. Proposed Trunk Sewers, Hudson River Watershed Area, Wastewater Facilities Report, Town of Colonie, Albany County, New York, March 1971.

31. Assuming linear growth rate between 1973 and year 2000 and using the projections from reference 32. below.

32. Preliminary Regional Development Plan, Capital District Regional Planning Commission, Spring, 1975, Appendix VII, Chart 2.

33. Implementation Plan to Achieve Air Quality Standards, Upstate New York, Division of Air Resources, Department of Environmental Conservation, State of New York, 1972.

34. Seasonal and Annual Wind Distribution of Pasquill Stability Classes, Star Program, White Plains, New York (1/68 - 12/72), National Climatic Center, Ashville, N.C.

35. Engineering Report, Stage 3, Rockland County Sewer District Number 1, Rockland County, New York, 1969.

36. Information obtained from the Rockland County Planning Commission, July, 1975.

37. Information obtained from the Tri-State Regional Planning Commission, July, 1975.

38. New York City Metropolitan Area Air Quality Implementation Plan, Department of Environmental Conservation, State of New York, Revised May, 1972, Table 8-11.

39. New York State Air Quality Report, Continuous Monitoring System, DAR-75-1, New York State Department of Environmental Conservation, 1974.

40. Federal Regulations. The Environmental Reporter, Bureau of National Affairs, Inc., Washington, D.C., 1973, pp. 121-0155.

APPENDIX A

DISCUSSION OF MEASURES TO MITIGATE ADVERSE AIR QUALITY IMPACTS

Measures to mitigate the adverse air quality impact of urban growth may be grouped into three basic categories:

- Control of Pollutant generating activities
- Control of source emissions
- Control of pollutant dispersion.

The applicant for a wastewater treatment project can only affect pollutant generating activities, to the extent that limitations in collection and treatment capacity limit growth. However, to effectively deal with air quality issues, he should understand the reange of potential mitigating measures. The appendix discusses briefly each of the above categories, and is intended to provide general background information.

1. CONTROL OF POLLUTANT GENERATING ACTIVITIES

Pollutant generating activities are generally categorized into point sources (fixed and mobile) and nonpoint or area sources. Potential restraints on point and nonpoint source categories include basic restraints on urban growth and/or the location of specific pollutant generating activities, and transportation controls which limit the use of vehicles. Specific mitigating measures in each of these areas are discussed below.

If the relationship between urban growth and air quality can be determined from the air quality impact assessment, then one of the mitigating measures considered could be to restrain the population growth in proportion to the required reduction in air quality impact. This implies the development of zoning restrictions which would indirectly limit the population in a given area. In major urban centers, such controls would have limited usefulness because of existing developments and existing zoning requirements. In addition to zoning restrictions, growth could conceivably be restrained by limiting wastewater service to a given area. The wastewater service could be limited in the following ways:

- Cut back the capacity of the treatment facility or interceptors and restrict growth to that capacity

- Build a treatment plant in stages and review the air quality at each stage to determine if further expansion is acceptable from an air quality standpoint.

Application of the above land use control techniques can be expected to be highly controversial, since the introduction of air quality planning into the land use issue is relatively new. Furthermore, the relationship between population growth and air quality may be complex, requiring the repetition of the air quality impact analysis with different growth scenarios.

The control of mobile sources through the application of transportation control strategies has also been a highly controversial issue for the past two years. Transportation control strategies include the following:

- Restriction on auto usage through exclusive bus and carpool lanes
- Auto commuting taxes and/or parking surcharges
- Restrictions on onstreet parking during commuting hours
- Limitations of offstreet parking during commuting hours
- Banning of automobiles from critical downtown areas.

The authority of EPA to impose such transportation controls has been removed by the courts, leaving the issue a local one. Since the automobile plays such an important part in American life today, this problem will not be easily solved. However, without a doubt, it is one of the key mitigating measures which will be required in the future to maintain air quality in critical Air Quality Maintenance Areas.

Finally, in new communities, land use planning can be used to reduce the number of automobile trips generated and the amount of home heating fuel consumed. A planned community minimizing the distance between residential and shopping areas, and providing mass transit alternatives, can significantly reduce the use of the private passenger car. Also, multifamily development generally results in more efficient use of heating fuel, thus reducing the amount of fuel burned and the resultant emissions. Again however, such planning is restricted primarily to new communities and would have limited impact on the major urban areas which presently comprise the bulk of the designated AQMA's.

2. CONTROL OF SOURCE EMISSIONS

One new concept for controlling point source emissions is the concept of "emission density zoning." Emission density zoning regulations would place a legal limit on the amount of an air pollutant that may be emitted in any given time period from a unit area. If this area represents an industrial plant, it puts the burden upon the owner to control whatever multiple sources may exist on the site to conform with the overall emission requirements, regardless of specific point source requirements represented by EPA emission guidelines. Of course, these latter emission control requirements can also be tightened for specific point sources, where areawide requirements so indicate.

In the case of vehicle emissions, new car emission controls have already significantly reduced emissions since 1969, and many states are now adopting a vehicle inspection and maintenance program to assure that these emission reduction gains are maintained. Emissions inspection and the resulting vehicle maintenance places a significant economic burden upon the consumer, and can also be expected to be a controversial local issue. In weighing vehicle inspection and maintenance requirements, it will be necessary to conduct tradeoff studies of the cost to the consumer of the inspection program versus transportation controls which would limit the use of automobiles altogether in critical air quality areas.

3. CONTROL OF POLLUTANT DISPERSION

Major point emission sources may be dispersed over a larger area by increasing the height of an exhaust stack. The resulting effect would be lower pollution concentration at the ground level, where the most impact is felt. EPA has generally frowned upon this alternative for air quality control, but it is mentioned here for completeness.

APPENDIX B

DISCUSSION OF METHODS TO ESTIMATE VEHICLE MILES TRAVELLED (VMT)

Three different levels of analysis are outlined for estimating both baseline and future year vehicle miles of travel (VMT). The three levels correspond to variable levels of effort and not necessarily to differing degrees of accuracy.

- Level 1. Several methods are described for estimating subcounty VMT using "broad-brush" statistics pertaining to roadway mileage, automobile ownership, and average VMT per vehicle.

- Level 2. The approach outlined under this level of effort involves the use of county traffic volume and roadway inventory data.

- Level 3. This level makes use of special data and studies done for the region, county, and subcounty areas. In that it incorporates land-use and travel parameters unique to the subcounty study area, it is more sensitive to the individual factors which contribute to internally generated VMT than Level 1 and Level 2 methods. The professional effort required with this approach, however, is considerably greater than with the other methods.

1. INVENTORY UPDATING PROCEDURES

Total vehicle miles of travel (VMT) within a given area is the resultant of three components of travel —— trips which both begin and end within the study area (denoted internal-internal); trips with one end of the trip within and the other outside the study area (denoted internal-external); and trips which only pass through the study area enroute elsewhere (denoted external-external). Past studies have shown that internal-internal, and internal-external trips are integrally related to population, land-use, and demographic characteristics of the study area. Through trips (external-external), however, occur independent of population and land-use characteristics of the study area. In this connection, most of the VMT analysis/projection techniques described herein, deal with internally generated travel and "through" travel as separate components.

(1) Level 1

It is likely for most major urban areas that base year VMT data is available at least on a countywide basis. Procedures are presented, however, both for allocating VMT to a subcounty area when countywide VMT is known, as well as when countywide VMT data is not available.

- Method 1. Assuming countywide VMT estimates are available, subcounty VMT can be approximated by using subcounty to county proportions of route or lane miles. This approach is predicted on roadway supply (i.e., route lane mileage) being proportionately related to demand (i.e., VMT). To account for the differing traffic volumes typically carried per lane mile on freeways vs. other highways vs. local streets, the following formula which incorporates weighting factors is recommended:

$$VMTs = VMTc\ (3Fs + 2Hs + As)/(3Fc + 2Hc + Ac)$$

where:

VMTs = Subcounty VMT

VMTc = County VMT

F = Freeway lane miles

H = Highway lane miles

A = Arterial street lane miles

s refers to subcounty

c refers to county

The above weighting factors are based upon approximate per lane capacity differences for the various categories of roadways as established in the Highway Capacity Manual, 1965.[1] It should be noted that local streets other than arterials need not be included in computing roadway mileage in that typically only 15 to 20 percent of total VMT occurs on these

(1) Highway Capacity Manual, 1965, Highway Research Board Special Report 87, National Academy of Sciences, National Research Council Publication 1328.

streets. Route and lane miles for county and subcounty areas can be obtained from county highway or planning departments or scaled from county base maps.

- Method 2. To establish internally generated VMT, this estimation technique involves the straight forward multiplication of the number of automobiles owned in the subcounty study area by the annual VMT per vehicle. Automobile ownership data at county, minor civil division (MCD), and census tract detail is available from U.S. Census reports. Average annual mileage per vehicle is usually available at county, region, or state detail. This method can be expressed as:

  VMT = (population) x (vehicles/person) x (VMT/vehicle)

In order to obtain the VMT by the various vehicle classes, the toal or automobile VMT obtained for the above methods should be multiplied by appropriate factors. Such factors may be obtained from local transportation studies, otherwise national statistics may be used.

(2) Level 2

For most major urban areas, base year VMT data is available at least on a countywide basis. A procedure for allocating countywide VMT to a subcounty area is described utilizing county or state highway department traffic flow maps and roadway inventory data (see Table 1). By eliminating the final two steps, however, which involve the calibration of Level 2 procedure findings with county VMT estimates, the below outlined approach is viewed as a suitable method for establishing subcounty VMT in the absence of prior countywide estimates.

- Step 1. Color code roadway segments on county traffic flow maps to correspond with functional classifications shown in column (1).

- Step 2. Fill in columns (2) through (8) for Study Area freeways on a roadway segment-by-segment basis.

- Step 3. Multiply the volumes in columns (6), (7), and (8) by the route miles in column (5), and enter the resulting products into columns (9), (10), and (11), respectively.

- Step 4. Compute the weighted average speed for Study Area freeways by multiplying for each Study Area entry column (4) by column (11) and dividing the sum by total Study Area VMT.

- Step 5. Repeat Steps 2 through 4 for the other roadway functional classifications.

VMT Summary

(1) Functional Classification	Segment Identification (2) Begin	(3) End	(4) Average Speed (mph)	(5) Route Miles	Annual Average Daily Traffic (6) Auto	(7) Trucks	(8) Total Vehicle	VMT (9) Auto	(10) Trucks	(11) Total Vehicles
<u>A. Freeway</u>										
1										
2										
Subtotal Study Area										
n										
Total Freeway										
<u>B. Other Highway</u>										
1										
2										
Subtotal Study Area										
n										
Total Other Highway										
<u>C. Arterials</u>										
1										
2										
Subtotal Study Area										
n										
Total Arterials										
<u>D. Local Streets</u>										
1 Total Study Area										
2 Total County										
TOTAL STUDY AREA										
TOTAL COUNTY										

- Step 6. Sum columns (5) through (11) sub-totals for the Study Area and enter in the appropriate row totals at the bottom of the table.

- Step 7. Perform Steps 2 through 6 for the balance of roadways within the county.

- Step 8. Compute an adjustment factor by dividing the county's own estimate of VMT by the county VMT established through the above calculations and multiply the sub-county total by this adjustment factor.

It is unlikely that all of the input data specified with the above approach is actually available. Traffic volumes on local arterial streets, for example, are rarely recorded other than on a spot basis. Traffic counts are usually available, however, for all freeways and most major highways. Vehicle classification data (i.e., trucks vs. autos is also usually only available for a few selected locations. In this connection, the above approach requires certain judgments on the part of the user. To the extent that average daily traffic data at known locations establish a pattern which can be used to approximate volumes on "like" roadway segments, the above method can still be considered reasonably accurate. One end product of this approach — average speed is a useful parameter for air quality calculations.

(3) Level 3

The approach outlined under this level embodies a simplification of the modelling techniques used in the comprehensive transportation planning process. It is responsive to the unique land-use and demographic characteristics of a Study Area, and builds upon these characteristics to establish vehicle trip generation and attraction rates; volumes of travel between sub-county areas or zones, between these zones and external locations; and the average trip length (vehicle miles of travel) which are accumulated with the subcounty Study Area in making these trips.

In that a significant portion of VMT which occurs within a subcounty area comprises trips to and from other county subareas (including those which only pass through the study area), the methodology presented comprises estimation of total countywide VMT, and the extraction of subcounty area VMT from the overall county total. Through traffic (i.e., external-external) is estimated using a similar approach to that outlined under Level 2. Specific steps are as follows:

- Step 1. Define analysis zones consistent with some subcounty areal unit at which population and land-use is forecast. Usually these zones would correspond to municipality boundaries or groups of municipalities. External zones (i.e., those outside the county) could correspond to county boundaries.

- Step 2. Determine from past 3-C transportation planning studies home-based person trip generation rates by type of dwelling unit or density (e.g., single family and multifamily housing) applicable for the county.

- Step 3. Establish the number of dwelling units by type within each Analysis Zone during the base year from prior land use inventories.

- Step 4. Determine total daily person trip productions for each Analysis Zone.

- Step 5. Determine from past 3-C transportation planning studies person trip attraction rates for nonresidential land-uses applicable for the county.

- Step 6. Establish base year nonresidential acreage within each county Analysis Zone from prior land-use inventories.

- Step 7. Determine total daily person trip attractions for each Analysis Zone.

- Step 8. Using the above person trip production/attraction estimates, develop a trip distribution matrix which links zonal productions and zonal attractions.

  Several methods have been developed in comprehensive transportation studies for linking or distributing productions and attractions.

The three most commonly used are the Growth Factoring (or Fratar Method); Gravity Model; and the Intervening Opportunities Model. Descriptions of these models are given in PB 237-867, Air Quality, Land Use and Transportation Models published by the California State Air Resources Board.(2) These models are developed using data established through in-depth home interview surveys and are based upon trip interchange between any two analysis zones being related to the relative spatial separation between these zones as compared to the spatial separation of the production zone and all other attraction zones. Travel impedence factors, if available from prior 3-C comprehensive planning studies, can be used as a guide in developing the trip distribution matrix. In the absence of impedence data, judgment on the part of the user utilizing some substitute for impedence factors, such as travel time, travel distance, etc., between zones will be necessary to develop the trip distribution matrix. At a minimum, however, the proportion of travel which occurs internal to the county and to and from the county should be available from prior 3-C planning studies.

(2) Air Quality, Land Use and Transportation Models. Evaluation and Utilization in the Planning Process, California State Air Resources Board, PB 237-867, July, 1974.

- <u>Step 9</u>. The next step involves the <u>conversion of person trips to vehicle trips</u>. Again, prior 3-C planning study findings, in this case with respect to mode usage and automobile occupancy factors, should be relied upon. If appropriate and available, separate conversion factors should be developed for internal-internal and internal-external trips. The process involves the multiplication of each entry in the trip distribution matrix by the corresponding person trip to vehicle trip conversion factor, and entering the resultant vehicle trips into a vehicle trip distribution table.

- <u>Step 10</u>. This step comprises <u>development of a trip length matrix</u> for the roadway mileage which would be traversed within the boundaries of the Study Area in travelling between each Analysis Zone pair. These mileage data can be approximated using county roadway maps, and certain judgments as to the likely travel routes which would be used when travelling between any two zones. In general, these over-the-road distances are approximately one-third greater than straight airline distances.

- <u>Step 11</u>. By multiplying the volume of vehicular travel between each zone pair established in Step 9 by the corresponding trip length determined in Step 10, a <u>matrix table of the vehicular miles of</u>

travel accumulated daily between each zone pair is produced. Summation of the individual zone-to-zone estimates yields total private auto VMT which occurs within the Study Area.

- Step 12. To account for other vehicular traffic, vehicle classification counts taken on Study Area roadways or the other vehicles factors developed from prior 3-C transportation planning studies should be used to factor private auto VMT established in Step 10 to total vehicle VMT.

- Step 13. The final step in the analysis is to add VMT produced by through traffic to that which has been calculated in the preceding steps. The approach recommended is to estimate total VMT which occurs on "through" roadways using recorded traffic counts and mileage data for these facilities, and to subtract out that portion of the recorded traffic which based upon the foregoing estimates is being produced by internally generated trips. The through traffic VMT may be divided according to the various vehicle classification as discussed in the previous step.

2. FORECAST PROCEDURES

Presented herein are various methods for forecasting future year vehicle miles of travel. Three different levels of analysis, consistent with precedures presented in the inventory and updating section are outlined.

(1) Level 1

It is likely for most major urban areas that future year VMT has been forecast at least at countywide detail. Procedures are presented, however, both for allocating projection year VMT to a subcounty area based upon available countywide projections, as well as for projecting forecast year VMT in the absence of prior projections.

- Method 1. Assuming countywide VMT forecasts are available, subcounty VMT can be approximated by using subcounty to county proportions of route or lane miles. Future year route and/or lane miles can be extracted from county roadway master plans. The formula to be used for projection year forecasts is identical to that presented in the inventory upgrading and updating section, with the substitution of future year for base year input data.

- Method 2. To establish future year VMT, this estimation technique involves the use of projected subcounty population, auto ownership, and annual average VMT per vehicle. To project the VMT, use the formula given for base year estimate with the above quantities.

(2) Level 2

Projecting future year VMT with this technique involves the factoring of base year traffic volumes by annual growth factors used by the county highway department, or the direct use of traffic volume projections evolved through 3-C comprehensive transportation planning traffic assignments. The first approach is suitable for short-term (5 to 10 year) forecasts, the latter for longer term projection periods. The latter approach is also more suitable when significant changes to the roadway system are expected within the forecast period. The method comprises the updating of annual average daily traffic volumes (shown in columns (6), (7), and (8) in Table 1 of the inventory upgrading and updating section) for each roadway segment inventoried in the base year. New roadway segments if programmed for opening within the forecast period should also be added to the inventory tabulations. Other than the above updating, the general procedures with this method are the same as presented previously for Level 2.

(3) Level 3

The methodology used for forecasting future year VMT for this level is identical to that presented previously. Input parameters with respect to forecast year land-use, person trip production and attraction rates, mode usage, and vehicle occupancy factors must be updated, however.

APPENDIX C

APPLICATION OF PROPOSED METHODOLOGY TO ESTIMATING VMT IN ROCKLAND COUNTY SEWER DISTRICT No. 1

Presented in this section are illustrative examples of the various base year VMT estimation and forecasting methodologies as applied to Rockland County, New York, Sewer District No. 1. In developing these estimates, various Tri-State Regional Planning Commission and Rockland County Planning Board Reports and data were used. Sources relied upon most heavily are:

- Interim Technical Report 4471-1302, Projecting Vehicle Miles of Travel in a Metropolitan Region, Tri-State Regional Planning Commission, September 1967.

- Interim Technical Report 4471-1302, 1970 County-to-County Travel By Purpose, Tri-State Regional Planning Commission, September 1974.

- Interim Technical Report 4456-1508, Vehicle Trip End Forecasts 1985, 1990, and 2000, Tri-State Regional Planning Commission, June 1974.

- Various Rockland County Planning Board data pertaining to population forecasts, automobiles available, road mileage, traffic volumes, land-use inventory, work location, and dwelling unit inventory.

LEVEL 1 BASE YEAR VMT ESTIMATES
ROCKLAND COUNTY SEWER DISTRICT NO. 1

AVERAGE DAILY 1975 VMT ESTIMATES

METHOD 1

$$\text{Sub-County VMT} = \frac{3\left(\begin{array}{c}\text{Sub-County Freeway}\\ \text{Route Miles}\end{array}\right) + 2\left(\begin{array}{c}\text{Sub-County Highway}\\ \text{Route Miles}\end{array}\right) + \begin{array}{c}\text{Sub-County Arterial}\\ \text{Route Miles}\end{array}}{3\left(\begin{array}{c}\text{County Freeway}\\ \text{Route Miles}\end{array}\right) + 2\left(\begin{array}{c}\text{County Highway}\\ \text{Route Miles}\end{array}\right) + \begin{array}{c}\text{County Arterial}\\ \text{Route Miles}\end{array}} \times \text{County-Wide VMT}$$

$$\text{Sewer-District VMT} = \frac{3\ (24) + 2\ (50) + 80}{3\ (47) + 2\ (78) + 117} \times 3.50 \times 10^6$$

$$= .609 \times 3.50 \times 10^6 = 2.13 \times 10^6$$

METHOD 2

$$\text{1975 Sub-County VMT} = \text{Base Year Population} \times \left(\begin{array}{c}\text{Autos Per}\\ \text{Person}\end{array}\right) \times \left(\begin{array}{c}\text{Annual VMT}\\ \text{Per Vehicle}\end{array}\right) \div 365$$

$$= 144{,}000 \times .388 \times \frac{13{,}250}{365} = 2.028 \times 10^6$$

APPENDIX C(2)

LEVEL 1 FORECAST YEAR VMT ESTIMATES
ROCKLAND COUNTY SEWER DISTRICT NO. 1

AVERAGE DAILY 1980 VMT ESTIMATES

METHOD 1

$$\text{Sub-County VMT} = \frac{3\,(\text{Sub-County Freeway Route Miles}) + 2\,(\text{Sub-County Highway Route Miles}) + \text{Sub-County Arterial Route Miles}}{3\,(\text{County Freeway Route Miles}) + 2\,(\text{County Highway Route Miles}) + \text{County Arterial Route Miles}} \times \text{County-Wide VMT}$$

$$\text{Sewer District VMT} = \frac{3\ (24) + 2\ (50) + 85}{3\ (47) + 2\ (78) + 130} \times 4.4 \times 10^6$$

$$= .602 \times 4.4 \times 10^6 = 2.65 \times 10^6$$

METHOD 2

$$\text{1980 Sub-County VMT} = \text{Projected 1980 Population} \times \text{Projected Autos Per Person} \times \text{Projected Annual VMT Per Vehicle} \div 365$$

$$= 166{,}300 \times .407 \times \frac{12{,}725}{365} = 2.36 \times 10^6$$

LEVEL 2 VMT ESTIMATES

ROCKLAND COUNTY SEWER DISTRICT NO. 1

Average Daily 1975 Summary Estimate (Sewer District No. 1)

Functional Classification	Average Speed (mph)	Route Miles	Annual Average Daily Traffic	Estimated VMT (000s)
Freeways	47	24	28,000	672.0
Other Highways	37	50	12,000	600.0
Arterials	25	80	6,000	480.0
Local Streets	15	365	1,000	365.0
TOTAL	35	519		2,117.0

Estimated Average Daily 1980 Summary Estimate (Sewer District No. 1)

Functional Classification	Average Speed (mph)	Route Miles	Annual Average Daily Traffic	Estimated VMT (000s)
Freeways	47	24	33,500	804.0
Other Highways	37	50	14,000	700.0
Arterials	25	85	6,600	561.0
Local Streets	15	420	1,000	420.0
TOTAL	35	579		2,485.0

SUMMARY OF LEVEL 3 AVERAGE DAILY VMT ESTIMATES (000s)

ROCKLAND COUNTY SEWER DISTRICT NO. 1

	Internally Generated VMT			
Base Year-1975	Autos	Other	Through Traffic	Total VMT
Within County	2,127.9	106.4	900.0	3,134.3
Within Sewer District	1,425.3	71.3	550.0	2,046.6
Projection Year-1980				
Within County	4,247.6	121.4	1,080.0	3,629.0
Within Sewer District	1,643.7	82.2	660.0	2,385.9

LEVEL 3 ANALYSIS
ESTIMATED 1975 POPULATION AND
LAND USE CHARACTERISTICS - ROCKLAND COUNTY

Zone[1]	Population	Dwelling Units		Commercial-Industrial Acres
		Single-Family	Multi-Family	
A	68,535	15,110	3,110	1,130
B	77,410	14,555	6,830	435
C	59,765	10,995	4,480	960
D	32,655	5,535	3,200	515
E	16,350	3,540	700	415
F	15,235	2,760	2,135	315
Total	269,950	52,495	20,455	3,770

ESTIMATED 1975 PERSON TRIPS

Zone	Productions			Attractions
	Single-Family	Multi-Family	Total	
A	105,920	15,270	121,190	149,400
B	102,030	33,535	135,565	54,050
C	77,075	21,995	99,070	119,275
D	38,800	15,710	54,510	63,990
E	24,815	3,435	28,250	51,560
F	19,350	10,485	29,835	39,145
Total	367,990	100,430	468,420	468,420

(1) See Appendix C(13) for Zone Delineation

ESTIMATED 1975 PERSON TRIP DISTRIBUTION (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	47.2	14.0	30.0	3.9	3.8	3.0	19.3	121.2
B	33.9	17.8	24.7	13.4	14.1	10.1	21.6	135.6
C	19.8	5.0	33.3	11.1	8.2	5.9	15.8	99.1
D	8.5	3.5	5.8	21.5	5.7	0.8	8.7	54.5
E	3.7	2.2	3.2	2.6	11.1	1.0	4.5	28.3
F	4.9	3.0	3.3	1.3	0.5	12.0	4.8	29.8
Outside County	22.4	8.6	19.0	10.2	8.2	6.3	-	74.7
Total	140.4	54.1	119.3	64.0	51.6	39.1	74.7	543.2

ESTIMATED 1975 VEHICLE TRIP DISTRIBUTION (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	22.0	6.5	14.0	1.8	1.8	1.4	10.1	57.6
B	15.8	8.3	11.5	6.2	6.6	4.7	11.4	64.5
C	9.2	2.3	15.5	5.2	3.8	2.8	8.3	47.1
D	4.0	1.6	2.7	10.0	2.7	0.4	4.6	26.0
E	1.7	1.0	1.5	1.2	5.2	0.5	2.4	13.5
F	2.3	1.4	1.5	0.6	0.2	5.6	2.5	14.1
Outside County	11.8	4.5	10.0	5.4	4.3	3.3	-	39.3
Total	66.8	25.6	56.7	30.4	24.6	18.7	39.3	262.1

TRIP LENGTH WITHIN COUNTY (MILES)

From Zone:	To Zone: A	B	C	D	E	F	Outside County
A	3.0	5.0	9.5	4.5	7.0	15.0	12.0
B	5.0	3.0	8.5	10.5	13.0	6.5	9.0
C	9.5	8.5	4.5	14.0	16.5	13.5	6.5
D	4.5	10.5	14.0	2.0	2.0	13.5	15.0
E	7.0	13.0	16.5	2.0	1.5	16.0	17.0
F	15.0	6.5	13.5	13.5	16.0	1.5	12.0
Outside County	12.0	9.0	6.5	15.0	17.0	12.0	-

TRIP LENGTH WITHIN SEWER DISTRICT (MILES)

From Zone:	To Zone: A	B	C	D	E	F	Outside County
A	3.0	5.0	7.5	3.0	3.5	14.5	9.0
B	5.0	3.0	6.5	7.5	7.5	6.0	6.5
C	7.5	6.5	-	9.0	9.0	11.0	2.0
D	3.0	7.5	9.0	-	-	10.5	9.0
E	3.5	7.5	9.0	-	-	10.5	9.0
F	14.5	6.0	11.0	10.5	10.5	-	9.0
Outside County	9.0	6.5	2.0	9.0	9.0	9.0	-

ESTIMATED 1975 INTERNALLY GENERATED VMT WITHIN COUNTY (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	66.0	32.5	133.0	8.1	12.6	21.0	121.2	394.4
B	79.0	24.9	97.8	65.1	85.8	30.6	102.6	485.8
C	87.4	19.6	69.8	72.8	62.7	37.8	54.0	404.1
D	18.0	16.8	37.8	20.0	5.4	5.4	69.0	172.4
E	11.9	13.0	24.8	2.4	7.8	8.0	40.8	108.7
F	34.5	9.1	20.3	8.1	3.2	8.4	30.0	121.7
Outside County	141.6	40.5	65.0	81.0	73.1	39.6	-	440.8
Total								2,127.9

ESTIMATED 1975 INTERNALLY GENERATED VMT WITHIN SEWER DISTRICT (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	66.0	32.5	105.0	5.4	6.3	20.3	90.9	326.4
B	79.0	24.9	74.8	46.5	49.5	28.2	74.1	377.0
C	69.0	15.0	-	46.8	34.2	30.8	16.6	212.4
D	12.0	12.0	24.3	-	-	4.2	41.4	93.9
E	6.0	7.5	13.5	-	-	5.3	21.6	53.9
F	33.4	8.4	16.5	6.3	2.1	-	22.5	89.2
Outside County	106.2	29.3	20.0	48.6	38.7	29.7	-	272.5
Total								1,425.3

ESTIMATED 1980 POPULATION AND LAND USE CHARACTERISTICS - ROCKLAND COUNTY

Zone[1]	Population	Dwelling Units		Commercial - Industrial Acres
		Single-Family	Multi-Family	
A	80,000	16,850	4,850	1,370
B	88,800	16,285	8,560	500
C	63,200	11,515	5,000	1,010
D	40,000	6,650	4,315	630
E	20,000	4,095	1,255	500
F	18,000	3,180	2,555	375
Total	310,000	58,575	26,535	4,385

ESTIMATED 1980 PERSON TRIPS (000s)

Zone	Productions			Attractions
	Single-Family	Multi-Family	Total	
A	118,120	23,815	141,935	171,070
B	114,160	42,030	156,190	62,435
C	80,720	24,550	105,270	126,120
D	46,615	21,185	67.800	78,670
E	28,705	6,160	34,865	62,435
F	22,290	12,545	34,835	46,825
Total	410,610	130,285	540,895	547,555

(1) See Figure 1 for Zone Delineation.

(1) See Appendix B(13) for Zone Delineation.

1980 PERSON TRIP DISTRIBUTION (000s)

Origin Zone	A	B	C	D	E	F	Outside County	Total
	Destination Zone							
A	58.6	16.4	32.8	4.8	4.6	3.6	21.1	141.9
B	41.2	20.3	26.4	16.3	16.9	12.1	23.0	156.2
C	22.5	5.4	33.0	12.6	9.2	6.8	15.8	105.3
D	11.1	4.3	6.6	27.6	7.3	1.0	9.9	67.8
E	4.8	2.7	3.6	3.4	14.1	1.3	5.0	34.9
F	5.9	3.5	3.6	1.6	0.6	14.5	5.1	34.8
Outside County	27.0	9.8	20.1	12.4	9.7	7.5	-	86.5
Total	171.1	62.4	126.1	78.7	62.4	46.8	79.9	627.4

ESTIMATED 1980 VEHICLE TRIP DISTRIBUTION (000s)

Origin Zone	A	B	C	D	E	F	Outside County	Total
	Destination Zone							
A	27.3	7.6	15.3	2.2	2.1	1.7	11.1	67.3
B	19.2	9.5	12.3	7.6	7.9	5.6	12.1	74.2
C	10.5	2.5	15.4	5.9	4.3	3.2	8.3	50.1
D	5.2	2.0	3.1	12.9	3.4	0.5	5.2	32.3
E	2.2	1.3	1.7	1.6	6.6	0.6	2.6	16.6
F	2.8	1.6	1.7	0.7	0.3	6.7	2.7	16.5
Outside County	14.2	5.1	10.6	6.5	5.1	3.9	-	45.5
Total	81.4	29.6	60.1	37.4	29.7	22.2	42.0	302.4

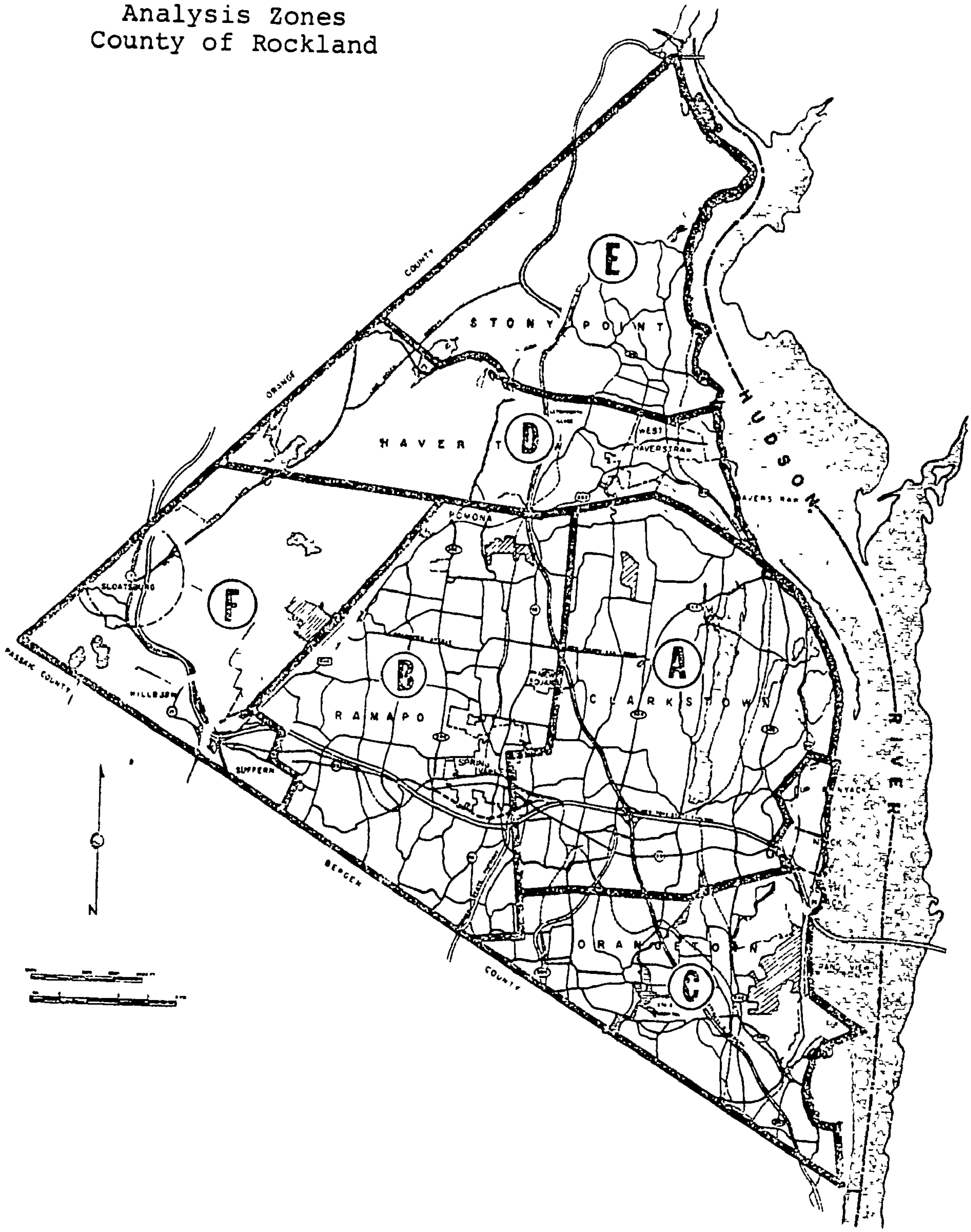
ESTIMATED 1980 INTERNALLY GENERATED VMT WITHIN COUNTY (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	81.9	38.0	145.4	9.9	14.7	25.5	133.2	448.6
B	96.0	28.5	104.6	79.8	102.7	36.4	108.9	556.9
C	99.8	21.3	69.3	82.6	71.0	43.2	54.0	441.2
D	23.4	21.0	43.4	25.8	6.8	6.8	78.0	205.2
E	15.4	16.9	28.1	3.2	9.9	9.6	44.2	127.3
F	42.0	10.4	23.0	9.5	4.8	10.1	32.4	132.2
Outside County	170.4	45.9	68.9	97.5	86.7	46.8	-	516.2
Total	528.9	182.0	482.7	308.3	296.6	178.4	450.7	2,427.6

ESTIMATED 1980 INTERNALLY GENERATED VMT WITHIN SEWER DISTRICT (000s)

Origin Zone	Destination Zone A	B	C	D	E	F	Outside County	Total
A	81.9	38.0	114.8	6.6	7.4	24.7	99.9	373.3
B	96.0	28.5	80.0	57.0	59.3	33.6	78.7	433.1
C	78.8	16.3	-	53.1	38.7	35.2	16.6	238.7
D	15.6	15.0	27.9	-	-	5.3	46.8	110.6
E	7.7	9.8	15.3	-	-	6.3	23.4	62.5
F	40.6	9.6	18.7	7.4	3.2	-	24.3	103.8
Outside County	127.8	33.2	21.2	58.5	45.9	35.1	-	321.7
Total	448.4	150.4	277.9	182.6	154.5	140.2	289.7	1,643.7

Analysis Zones
County of Rockland



APPENDIX D

STATE AMBIENT AIR QUALITY STANDARDS IN EPA REGION II

The EPA Region II includes the States of New York and New Jersey, Puerto Rico, and Virgin Islands. The ambient air quality standards (AAQS) for Puerto Rico and Virgin Islands are the same as the national ambient air quality standards (NAAQS) given in Table I-1. The AAQS for the state of New Jersey are also the same as the NAAQS, except for the secondary standards for TSP. The New Jersey AAQS include, in addition to the NAAQS, the following secondary standards for TSP: 60 microgram/m^3, annual arithmetic average and 260 microgram/m^3, 24-hour average not to be exceeded more than once per year. The New York AAQS for carbon monoxide, hydrocarbons, and photochemical oxidants are identical to the corresponding NAAQS. However, the ambient sulfur dioxide and particulate matter standards for the State of New York differ from the NAAQS. The New York SO_2 and particulates standards are discussed below.*

1. STANDARDS FOR SO_2

During any 12 consecutive months, 99 percent of the one-hour average concentrations shall not exceed 0.25 ppm (650 ug/m^3) and no one-hour average concentration shall exceed 0.50 ppm (1300 ug/m^3). During any 12 consecutive months, 99 percent of the 24-hour average concentrations shall not exceed 0.10 ppm (260 ug/m^3); and no 24-hour average concentration shall exceed 0.14 ppm (365 ug/m^3). During any 12

* The Environment Reporter, State Air Laws, Bureau of National Affairs, Inc., Washington, D.C.

consecutive months, the annual average of the 24-hour average concentrations shall not exceed 0.03 ppm (80 ug/m^3).

2. STANDARDS FOR PARTICULATES

The State of New York has established standards for suspended as well as settleable particulates. The standards in different parts of the state vary according to the air quality classification. The classification is based on land uses and includes four classes, Level I through Level IV. The Level I areas represent the cleanest areas, whereas Level IV the most developed. The standards for the four classes are given below:

(1) Suspended Particulates

For any 24-hour period, the average concentration shall not exceed 250 ug/m^3 for all levels. During any 12 consecutive months, 50 percent of the values of the 24-hour average concentrations shall not exceed:

Level I - 45 ug/m^3
Level II - 55 ug/m^3
Level III - 65 ug/m^3
Level IV - 75 ug/m^3

During any 12 consecutive months, 84 percent of the values of the 24-hour average concentrations shall not exceed:

Level I - 70 ug/m^3
Level II - 85 ug/m^3
Level III - 100 ug/m^3
Level IV - 110 ug/m^3

(2) Settleable Particulates (Dustfall)

During any 12 consecutive months, 50 percent of the values of the 30-day average concentrations shall not exceed:

Level I	-	0.30 $mg/cm^2/mo$
Level II	-	0.30 $mg/cm^2/mo$
Level III	-	0.40 $mg/cm^2/mo$
Level IV	-	0.60 $mg/cm^2/mo$

During any 12 consecutive months, 84 percent of the values of the 30-day average concentrations shall not exceed:

Level I	-	0.45 $mg/cm^2/mo$
Level II	-	0.45 $mg/cm^2/mo$
Level III	-	0.60 $mg/cm^2/mo$
Level IV	-	0.90 $mg/cm^2/mo$

APPENDIX E

INPUT REQUIREMENTS OF THE MODIFIED ROLLFORWARD MODEL FOR CO

The modified rollforward model for CO is described in Chapter III. This appendix presents the procedure to obtain the input data for the model. The input requirements include:

- Baseline ambient CO concentration (B)
- Background CO concentration (b)
- General urban emissions data (P, G, and E)
- Local emissions data (P, G, and E)

1. BASELINE CO CONCENTRATION

Use the second highest 1-hour and 8-hour average CO concentrations during the base year at sites where the public has access for at least 1- and 8- hours respectively. If there are multiple monitoring sites, the data from the site with the worst concentrations should be used.

2. BACKGROUND CONCENTRATION

For estimating 8-hour average concentration, use 1 ppm if data to the contrary are unavailable. Similarly, for 1-hour concentration, 5 ppm may be used.

3. GENERAL URBAN EMISSIONS

General urban emissions data required include percent emissions by different source categories and corresponding growth and emission reduction factors in the service area.

The methods for estimating base year CO emissions from motor vehicles and other sources in the service area are described in Chapter IV. Divide the motor vehicle emissions into two groups:

- Light-duty vehicle emissions (Q_L) comprising emissions from automobiles and light-duty trucks
- Heavy-duty vehicle emissions (Q_H) comprising emissions from heavy-duty gasoline and diesel vehicles.

The motor vehicle emissions Q_L and Q_H together with the CO emissions from the other sources (Q_S) form the total CO emissions, Q_T. Obtain the percent emissions P_L, P_H, and P_S by dividing Q_L, Q_H, and Q_S respectively by Q_T.

The emission activity growth factors (G_L, G_H, and G_S) and the emission reduction factors (E_L, E_H, and E_S) for each category can be obtained separately. However, if the future emissions are already projected, the product (G X E) for each category can be obtained by taking the ratio of future emissions from each category to the corresponding base year emissions.

4. LOCAL EMISSIONS

The local emissions represent the emissions by motor vehicles travelling on the streets next to the monitoring site of interest. The emissions from stationary sources are also included. The percent emissions by light- and heavy-duty vehicles in the vicinity of the monitoring site may not, in general, equal those in the general urban area. The percentage of light-duty vehicles may be higher there than in the general urban area. Also, the local traffic growth rate is likely to be lower than that in the general urban area because of saturation with the existing traffic.

To obtain the local emissions data, determine the fraction (N_L and N_H) of light and heavy-duty vehicles travelling on the local streets during the base year from local traffic data. Determine the corresponding emission factors (e_L and e_H) from AP-42. Obtain the fraction (K_L and K_H) of light and heavy-duty vehicle emissions using the equations:

$$K_L = (N_L e_L)/(N_L e_L + N_H e_H)$$

and

$$K_H = (N_H e_H)/(N_L e_L + N_H e_H)$$

The percentage of stationary source emissions (P_S) in the vicinity of the monitoring sites may be assumed to be the same as that in the general urban area. Therefore, the local percentage (P_L and P_H) of light and heavy-duty vehicle emissions can be obtained using the equations:

$$P_L = K_L \times (100 - P_S)$$

and

$$P_H = K_H \times (100 - P_S)$$

The local traffic growth factors (G_L and G_H) can be determined from local transportation planning studies or from data obtained from local or state planning agencies.

The local emission reduction factors are assumed to be the same as those for the general urban area.